OCS Report
MMS 85-0091

Offshore Resource Evaluation Program: Background & Functions

MMS
U.S. Department of the Interior
Minerals Management Service
Offshore Resource Evaluation Division

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U.S. Department of the Interior
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Preface

The oil and gas resources on the Outer Continental Shelf belong to the people of the United States, who, through their Government, lease the right to explore and develop those resources. The Federal Government, through the Minerals Management Service, issues permits for prelease exploration activities, evaluates resources, leases acreage, and regulates drilling and production activities. This publication provides information about how these oil and gas resources are effectively evaluated.

The Outer Continental Shelf Lands Act, passed by Congress in 1953 and amended in 1978, is the basis for the procedures and activities to be discussed here.

This publication describes the procedures followed in evaluating offshore resources, beginning with the permitting and collecting of geologic and geophysical data and ending with the resource economic and engineering evaluations and analyses for a lease sale. It is a summary of the Minerals Management Service oil and gas resource evaluation program on the Outer Continental Shelf, the results of which are intended to assure the Government receipt of fair market value for these lands.

We hope this publication will provide you with a better understanding of the evaluation of oil and gas resources on the Outer Continental Shelf.

Acknowledgments

A work of this sort requires assistance from numerous sources. I would like to thank Malka Pattison for her input into the economic studies and evaluations and George Carpenter for providing the discussion on PRESTO.

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Acronyms

BLM—Bureau of Land Management
CD—Conservation Division (USGS)
CFR—Code of Federal Regulations
DOI—Department of the Interior
EEZ—Exclusive Economic Zone
EIS—Environmental Impact Statement
G&G—Geologic and Geophysical (data)
MMS—Minerals Management Service
MONTCAR—Monte Carlo Range of Values (methodology)
NEPA—National Environmental Policy Act
OCS—Outer Continental Shelf
OCSLA—Outer Continental Shelf Lands Act
OCSLAA—Outer Continental Shelf Lands Act Amendments
PRESTO—Probabilistic Resource Estimates—Offshore (methodology)
REIS—Resource Estimate Information System
USGS—U.S. Geological Survey

Chapter 1. Introduction

The Minerals Management Service (MMS) has the major responsibility for administering the Department of the Interior's (DOI) role in activities associated with mineral resource development on the Federal Outer Continental Shelf (OCS). These activities relate to the leasing, exploration, development, production, and royalty management of these mineral resources. The primary responsibility of the Resource Evaluation Program is to investigate the mineral potential of the OCS, predominantly for oil and gas, and to assure the receipt of fair market value for oil and gas leases on the OCS.

Formation of Minerals Management Service

In an effort to develop the oil and gas resources of the OCS, the United States established a leasing program to manage these resources. The Secretary of the Interior has been designated by the OCS Lands Act of 1953, as amended, to manage and regulate many of the activities related to the leasing, exploration, development, and production of the OCS mineral resources.

On January 19, 1982, Secretary of the Interior, James G. Watt, issued Secretarial Order No. 3071 establishing a Minerals Management Board and the Minerals Management Service that would be under the supervision of the Under Secretary.

Responsibilities of the MMS were formerly delegated to the Conservation Division (CD) of the U.S. Geological Survey (USGS), the Bureau of Land Management (BLM), and the Office of OCS Program Coordination. In January 1982, Secretary Watt issued the order that separated the CD from the USGS and changed its name to the MMS. In May 1982, Secretary Watt further expanded the MMS by signing an amendment to Secretarial Order No. 3071, consolidating all OCS leasing and resource management functions of the DOI's program offices into the MMS. In September 1982, Secretary Watt issued a Departmental Manual implementing the above orders with the intention of providing a more efficient management of the development of OCS resources. Under the original order, the MMS was supervised by a Minerals Management Board. In December 1982, Secretary Watt signed Secretarial Order No. 3087, abolishing the Minerals Management Board, and placing the MMS under the supervision of the Assistant Secretary for Land and Minerals Management. Figure 1 shows the relationship of MMS to the general organization of the Department of the Interior.

The MMS maintains regional offices for the Alaska OCS, the Atlantic OCS, the Gulf of Mexico OCS, and the Pacific OCS (for OCS waters along the west coast and off Hawaii). These four offices are headed by Regional Directors who are responsible for managing the leasing, development, and production program in their areas. In addition, the MMS has an Office of Strategic and International Minerals located in Long Beach, California, headed by a Program Director who is responsible for developing a program to lease strategic/critical and other nonenergy minerals on the OCS. The MMS offshore organization chart is shown in Figure 2.

Legislative Background

1. Statutory Authority for the Resource Evaluation Program

Jurisdiction over the offshore lands is divided between the Federal Government and the coastal States. In response to public concerns about the ownership and development of offshore resources, Congress, in 1953, enacted two laws that granted certain offshore lands to coastal States and provided a framework for regulating and managing exploration, development, and production of resources under the seabed beyond the area managed by the coastal States. The two acts are as follows:

The Submerged Lands Act. The Submerged Lands Act of May 22, 1953, granted the coastal States a belt of submerged lands seaward of their coastlines to a distance of 3 geographical miles. A greater distance from shore (about 3 marine leagues) was granted to Texas and Florida (west coast only) because these States had established jurisdiction over the larger area before achieving statehood. As a result of this Act, natural resources of the seabed beyond those granted to coastal States would be under the jurisdiction of the Federal Government.

The Outer Continental Shelf Lands Act and its Amendments. The OCS Lands Act of August 7, 1953, (1) reaffirmed that those lands beyond the 3 geographical mile limit, or more, are subject to the jurisdiction of the Federal Government, and (2) authorized the Secretary of the Interior to grant mineral leases to OCS lands and to provide regulations to carry out the provisions of the Act.

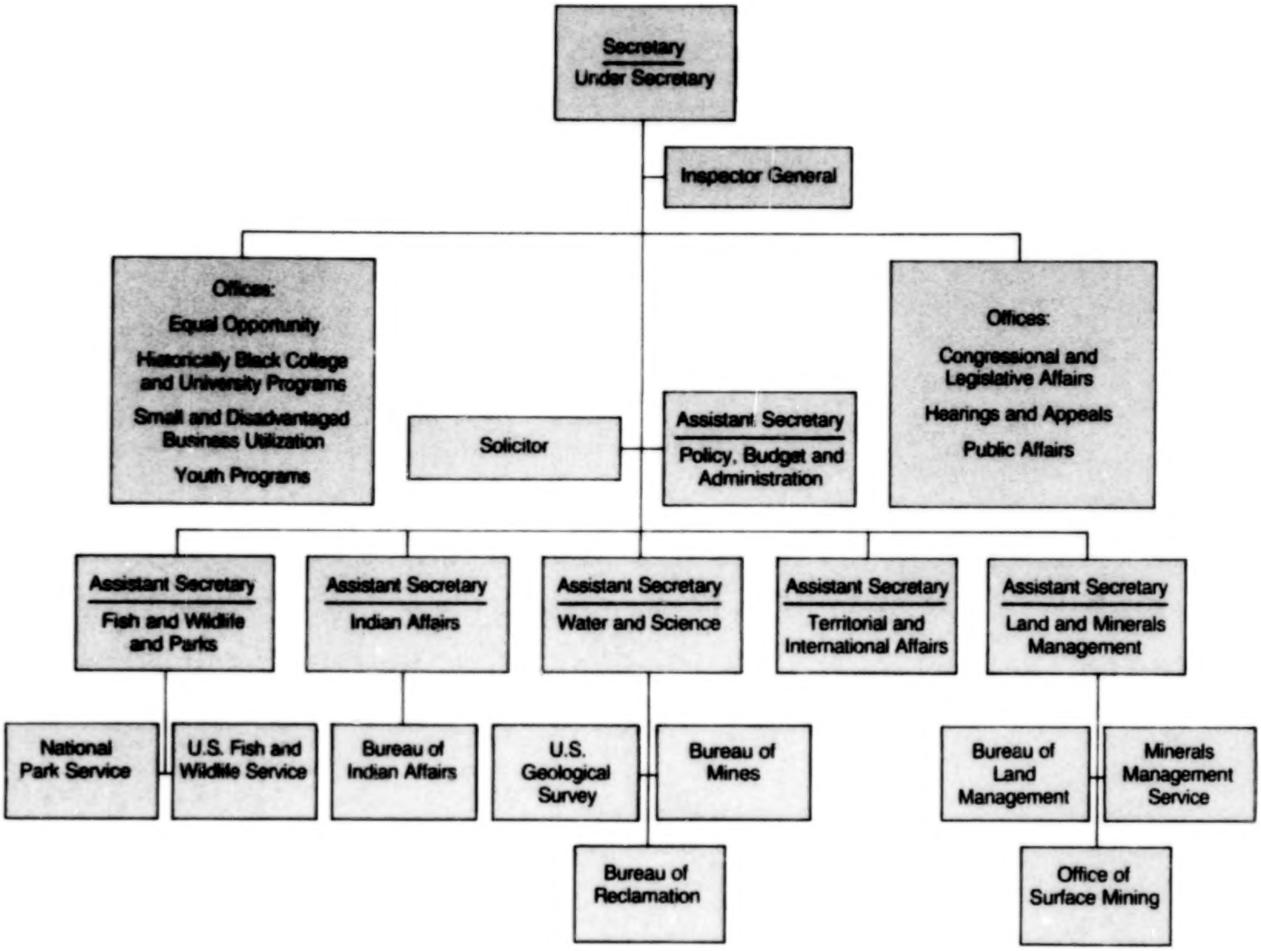


FIGURE 1. General Organization, U.S. Department of the Interior

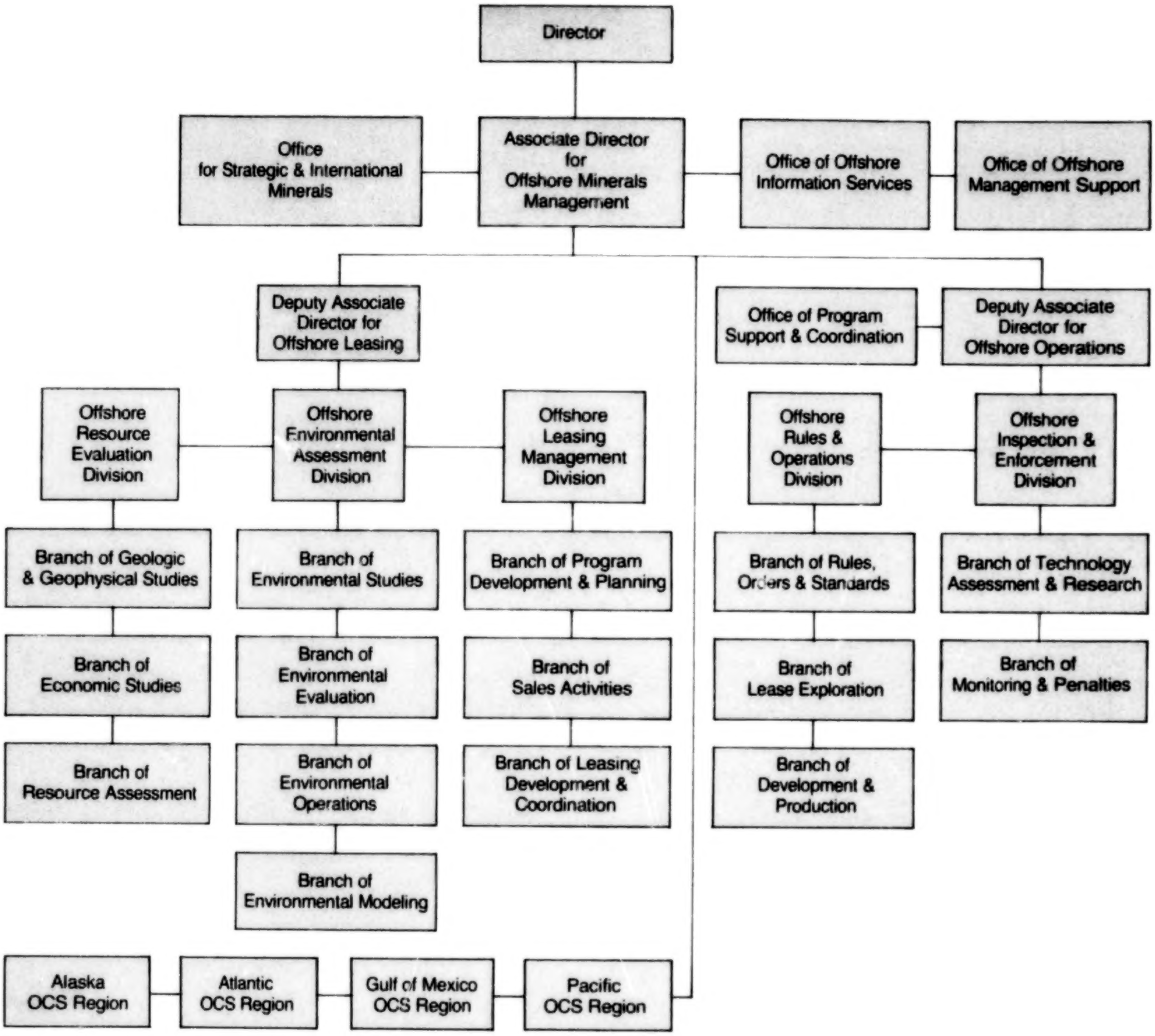

Director
Office for Strategic & International Minerals
Associate Director for Offshore Minerals Management
Office of Offshore Information Services
Office of Offshore Management Support
Deputy Associate Director for Offshore Leasing
Office of Program Support & Coordination
Deputy Associate Director for Offshore Operations
Offshore Resource Evaluation Division
Offshore Environmental Assessment Division
Offshore Leasing Management Division
Offshore Rules & Operations Division
Offshore Inspection & Enforcement Division
Branch of Geologic & Geophysical Studies
Branch of Economic Studies
Branch of Resource Assessment
Branch of Environmental Studies
Branch of Environmental Evaluation
Branch of Environmental Operations
Branch of Environmental Modeling
Branch of Program Development & Planning
Branch of Sales Activities
Branch of Leasing Development & Coordination
Branch of Rules, Orders & Standards
Branch of Lease Exploration
Branch of Development & Production
Branch of Technology Assessment & Research
Branch of Monitoring & Penalties
Alaska OCS Region
Atlantic OCS Region
Gulf of Mexico OCS Region
Pacific OCS Region

FIGURE 2. Offshore Minerals Management Service Organizational Chart

The Act was amended on September 18, 1978. The amendments established a policy for managing oil and gas on the OCS and required revision of bidding systems and lease administration, coordination and consultation with affected State and local governments, development of environmental studies for lease sale areas, and development of a 5-year leasing program. In addition, with regard to resource evaluation, the Secretary is required to assure the receipt of fair market value for OCS lands in oil and gas leasing.

Other Laws which Govern the OCS. Resource evaluation of the OCS is also subject to the requirements of other Federal laws administered by numerous Federal Departments and Agencies. Among them is the National Environmental Policy Act (NEPA) of 1969, which establishes requirements for preparation of environmental assessments and environmental impact statements for major Federal actions that could affect significantly the quality of the human environment. Included in the environmental impact statements are resource estimates and exploration, development, and production scenarios for oil and gas resources.

Regulatory Authority for the Resource Evaluation Program

Regulations. The MMS administers the provisions of the OCS Lands Act, as amended, through regulations found in Title 30 of the Code of Federal Regulations (CFR). The regulations govern leasing, permitting, collecting of data, and operations on the OCS. With regard to the Resource Evaluation Program, authority has been vested in the Secretary of the Interior under 30 CFR Part 251 to regulate the conduct of prelease geologic and geophysical (G&G) exploration for mineral resources on the OCS. Part 251 applies not only to G&G exploration but to scientific research as well. The purpose of these regulations is (1) to prescribe when a permit or the filing of a statement of intent to conduct G&G exploration on the OCS is required and (2) to prescribe operating procedures for conducting exploration, requirements for disclosing data and information, conditions for reimbursing permittees for certain costs, and other conditions under which exploration shall be conducted.

Basic Resource Evaluation Program

The Resource Evaluation Program consists of two components: (1) Geologic and Geophysical (G&G) Data Acquisition, Evaluations, and Analyses; and (2) Resource Economic and Engineering Evaluation and Analyses. Through these program components, the overall primary objectives of the Resource Evaluation Program are carried out as follows:

- Provide sound analytical and technical support for the offshore leasing process and the postlease regulatory activities, so that all activities can be carried out effectively and efficiently.
- Provide scientific data and information on the offshore to assure an adequate data base is available to the Secretary in support of leasing decisions.
- Provide resource estimates, exploration and development scenarios, and economic parameters and statistical data on lease sale areas.
- Provide resource economic evaluations and bid adequacy determinations for tracts bid upon in lease sales to assure that the Government receives fair market value for leased lands.
- Provide input into policies and mechanisms for leasing, development, and production of domestic sources of offshore strategic and critical mineral resources, including those in the Exclusive Economic Zone.

Some of the products of the Resource Evaluation Program must be produced as much as 2½ years before a planned lease sale. As a result, plans for budgeting and allocations of funds must be made years in advance. Over half the budget goes towards the analyses of G&G data. A percentage allocation of the funding for the Resource Evaluation Program is shown in Figure 3.

1. Geologic and Geophysical Data Acquisition and Analysis

The G&G Data Acquisition, Evaluations, and Analyses component of the Resource Evaluation Program provides information throughout the leasing process, focusing on the use of G&G data to identify and evaluate areas and tracts with potential for oil and gas. In the early stages of the leasing process, this component provides data, information, and analyses required for decisions that are made relative to entire planning areas. As the leasing process progresses, the focus shifts from planning areas to the specific area being offered for lease and the potential prospects within that area. Upon completion of the G&G evaluations used to determine bid acceptance/rejection, which occurs at the end of the sale process, the emphasis shifts again to the planning area for future sales. Prospect-specific maps and analyses are updated from new information, when appropriate, and added to the data base for future lease sales. The areawide analyses and mapping also identify promising areas that are used in reviewing and developing leasing schedules for oil and gas.

2. Resource Economic Evaluation

The Resource Economic and Engineering Evaluations and Analyses component uses information from the G&G Data Acquisition, Evaluations, and Analyses component and develops resource estimates and economic resource evaluations and analyses. The initial focus is on assessing the potential resources of entire planning areas, then on areas considered for leasing, and finally on tracts receiving bids in a sale.

Within this component, economic and engineering analyses of minimum economic field size, minimum bid level, and lease terms, among others, are carried out. These analyses are directly related to specific lease sales, and provide necessary information for overall program decisions.

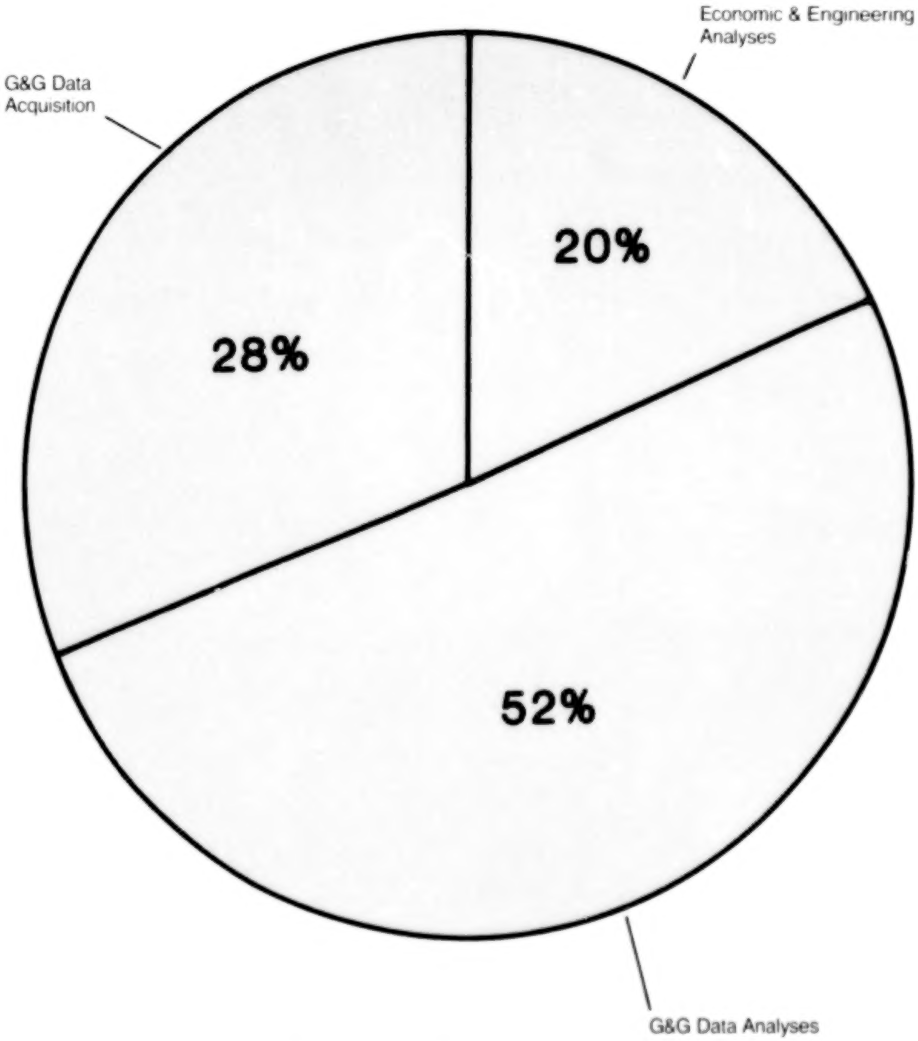


FIGURE 3. Hypothetical Resource Evaluation Program Budget (based on FY 85)

Chapter 2. Technical and Historical Background

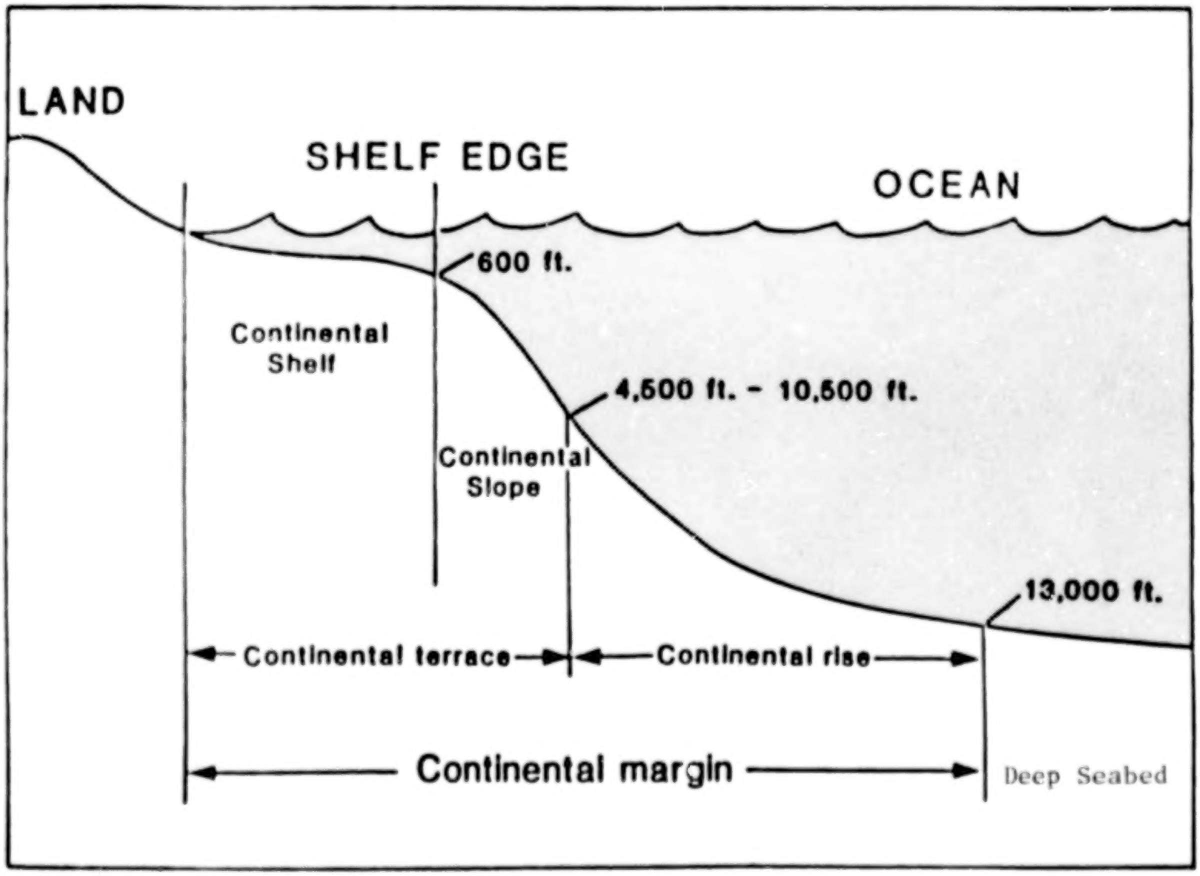
Outer Continental Shelf

The term, "continental shelf," is distinct from the term, "Outer Continental Shelf," which is a legal term created by Federal statute. There is no scientific definition for the OCS.

The submerged seaward extension of a continent is called the continental margin. In most areas, this submerged extension is composed of the gently sloping continental shelf and the steeper gradients of the continental slope. In some areas, an apron of material derived from the continent—the continental rise—extends from the base of the continental slope to the abyssal ocean floor. Figure 4 shows a generalized profile of the continental margin.

The contour and extent of the continental shelf vary from one coastal area to another. The shelf is relatively narrow along the Pacific coast, moderately wide along much of the Atlantic coast and the Gulf of Alaska, and broad in the Gulf of Mexico and around western and northwestern Alaska. It is generally defined as a gently sloping submerged marginal zone of the continents extending from the shore outward through shallow waters to a drop off at the continental slope in deeper waters.

Evaluation of oil and gas resources on the Federal



NOTE: Depths and gradients are approximate

FIGURE 4. Profile of the continental margin

OCS currently involves the submerged land generally 3 geographic miles from a State's coast to about 200 to 300 miles offshore.

The legal and physiographic definitions of the continental shelf are not the same. Legally, the OCS comprises that part of the continental margin adjacent to the United States which remained subject to Federal jurisdiction and control after enactment of the Submerged Lands Act. Under the 1958 Geneva Convention on the Continental Shelf, the seaward limit of the shelf is defined as ". . . a depth of 200 meters (656 feet) or, beyond that limit to where the depth of the superjacent waters admits of the exploitation of the natural resources of the said areas."

Exclusive Economic Zone

On March 10, 1983, a Presidential Proclamation established an Exclusive Economic Zone (EEZ) of the United States of America. The EEZ extends seaward 200 nautical miles from the "baseline" (the legal coastline) of the territorial sea of the United States, the Commonwealths of Puerto Rico and Northern Mariana Islands, and other U.S. overseas territories and possessions. The EEZ covers over 3 billion acres subject to U.S. jurisdiction.

Within the EEZ, the United States has sovereign rights, to the extent permitted by international law, to explore, exploit, conserve, and manage natural resources, both living and nonliving, of the seabed and subsoil. The Federal Government is authorized by the OCS Lands Act to manage the leasing of all minerals including oil and gas within the EEZ off the 50 States. Figure 5 shows the location of the EEZ.

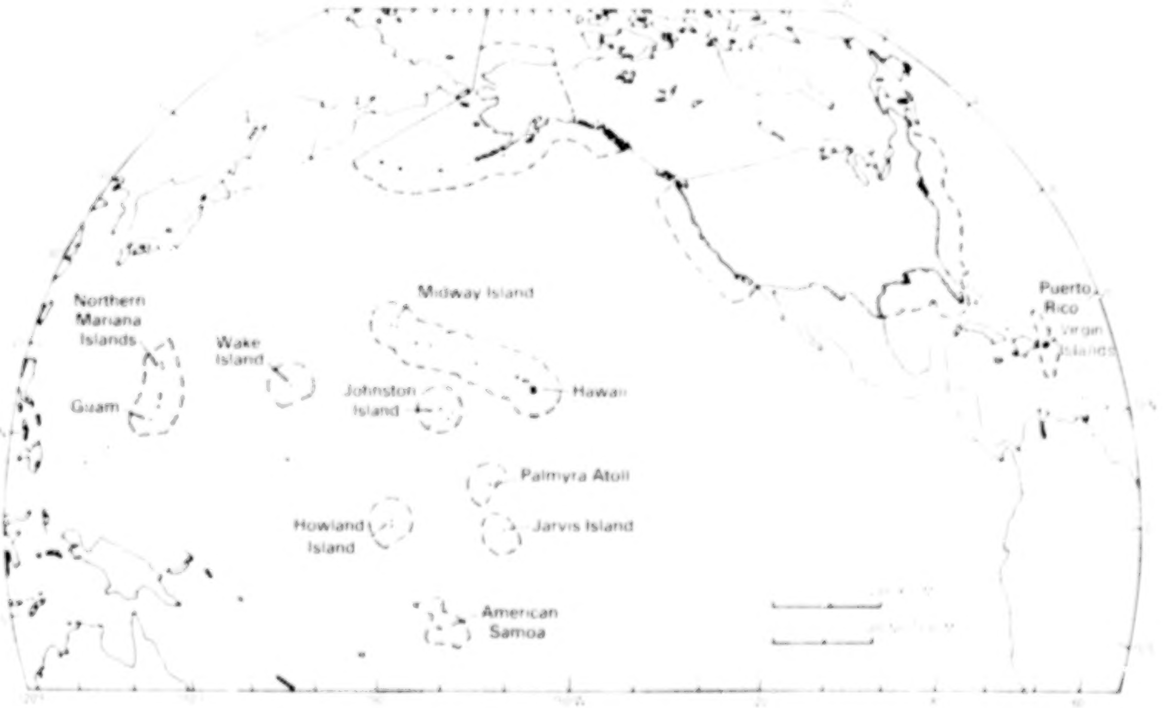


FIGURE 5. Exclusive Economic Zone (EEZ) of the United States, Commonwealth of Puerto Rico, Commonwealth of the Northern Mariana Islands, and the United States overseas territories and possessions. (Outlines of map are approximate)

Petroleum Geology

The Resource Evaluation Program addresses the mineral potential of the OCS, predominantly oil and gas, i.e., petroleum. Petroleum is found beneath the surface of the earth both onshore and on the continental shelf and slope. The key geologic requirements are (1) source rocks—organic-rich sediments which serve as a source of hydrocarbons, (2) reservoir rocks—porous and permeable rocks where the hydrocarbons can accumulate, (3) an impermeable capping rock which prevents the hydrocarbons from escaping, and (4) a favorable thermal history to transform the organics into hydrocarbons.

Most scientists believe that the majority of hydrocarbons are associated with rocks which were formed or deposited in a marine environment millions of years ago. Great volumes of organic and inorganic matter accumulated in these marine environments, and, as this material continued to accumulate, pressure was applied from the weight of the overlying sedimentary pile. This pressure, together with the heat of the earth, probably produced oil and gas from the organic matter. Scientists have proven that organic matter may be transformed into oil and gas by long-continued heat and pressure aided by bacterial action. Gradually, over millions of years, some of the oil and gas migrated into porous and permeable rocks.

Oil is not a homogeneous compound. Two primary elements—hydrogen and carbon—are combined in complex and various proportions. In crude oils, the amount of hydrogen varies from 10 to 15 percent and carbon from 80 to 89 percent by weight. Oil usually occurs with natural gas and saltwater within porous rocks. Gas is lighter than oil or water and tends to accumulate at the top of any reservoir. Most oil is lighter than water and also accumulates in the upper part of a reservoir, below the gas. Oil also contains minor amounts of other chemicals—sulfur, nitrogen—in its natural state or condition.

Porous and permeable rocks, such as sandstone or limestone, act as depositories or reservoirs for oil and gas if there is some geologic condition that acts as a seal. If the seal or trap results from the structure of the rock—such as a fold, salt dome intrusion, or fault—it is called a structural trap. If the seal simply resulted from (1) a loss of porosity or permeability of the host rock which prevents further migration of the oil and gas or (2) the halting of the upward movement of hydrocarbons by beds pinching out against impervious cap rock, it is known as a stratigraphic trap.

There are many different shapes, sizes, and types of geologic structures or traps that provide reservoirs in which petroleum is found as depicted in Figure 6.

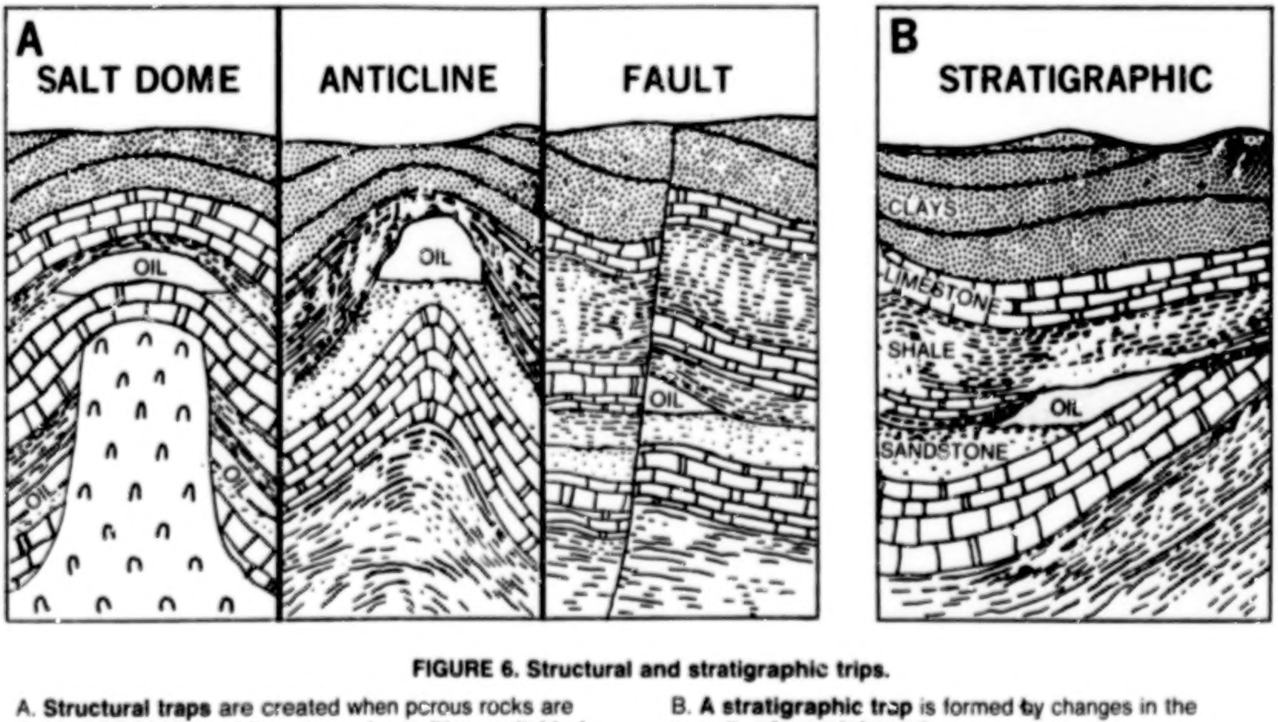


FIGURE 6. Structural and stratigraphic trips.

A. **Structural traps** are created when porous rocks are tilted and folded, providing reservoir conditions suitable for the accumulation of petroleum.

B. **A stratigraphic trap** is formed by changes in the porosity of a rock formation.

Perhaps the simplest means of classifying reservoirs is to group them according to the conditions causing their occurrence, as in the following:

1. Structural Domes and Anticlines—Reservoirs formed by folding of the rock layers or strata usually have the shape of structural domes or anticlines. These traps were filled by upward migration or movement of oil or gas (or both) through the porous strata or beds to the location of the trap. Here further movement was arrested by a combination of the form of the structure and the seal or cap rock provided by the formation covering the structure. Examples of reservoirs formed by domal structures are located offshore in the Gulf of Mexico and offshore California. An example of a reservoir formed by anticlinal structure is the Ventura Oil Field in California.

2. Fault Traps—Reservoirs are formed when strata are broken or sheared and offset. This is called faulting. The escape of oil from such a trap is prevented by nonporous rocks that have moved into a position opposite the porous petroleum-bearing formation. The oil is confined in traps of this type because of the tilt of the rock layers and the faulting. Examples of fields of this type exist along fault zones in offshore Texas.

3. Dome and Plug Traps—Accumulations of oil are found in porous formations on or surrounding great plugs or masses of salt or intrusive rock that have pierced, deformed, or lifted the overlying rock layers. Some typical accumulations of this type, illustrating a nonporous salt mass that has formed domeshaped traps in overlying and surrounding porous rocks, are located in the central and western offshore Gulf of Mexico.

4. Unconformities—A type of stratigraphic reservoir is formed as a result of an unconformity. Here the upward movement of oil has been halted by the impermeable cap rock laid down across the cut-off (possibly by water or wind erosion) surfaces of the lower beds. An example of this type of reservoir is the giant East Texas Field.

5. Pinchouts—Another type of stratigraphic reservoir is one that is sealed in its upper regions by abrupt changes in the amount of connected pore space. This may be caused in the case of sandstones by irregular depositing of sand pinching out into shale at the time the formation was laid down. In these cases, oil is confined within porous parts of the rock by the nonporous parts of the rock surrounding it. A reservoir of this type is found in the fields of west Texas. Often, however, the trapping mechanism results from a combination of structural and stratigraphic factors.

Resources and Reserves

The oil and gas potential of the offshore United States, including the continental shelf, is classified in four major categories as described below:

1. Undiscovered economically recoverable resources—Those potential commercial accumulations of resources, outside of known fields, estimated from geologic, engineering, and economic inferences. Specifically excluded are quantities that may be technically extractable but not economically so. Therefore, deposits are excluded that are too small, too dispersed, or too remote to be economically extractable under prevailing and forecasted cost-price relationships and technological trends. Because only a small part of the OCS has been explored and drilled, most of its potential resources remain in this category.

2. Measured reserves—That part of the economic identified resource that is estimated from geologic evidence supported directly by engineering measurements. Measured reserves here are equivalent to proved reserves as defined by the American Petroleum Institute (API) and others (1976).

3. Indicated reserves—The additional quantities of crude oil and gas in known reservoirs (in excess of the measured reserves) which are believed to be economically recoverable by application of secondary recovery techniques such as fluid injection, whether or not such a program is currently installed.

4. Inferred reserves—Quantities of oil and gas in known oil and gas fields that may be found by further drilling through extensions of producing layers and discovery of new pay zones.

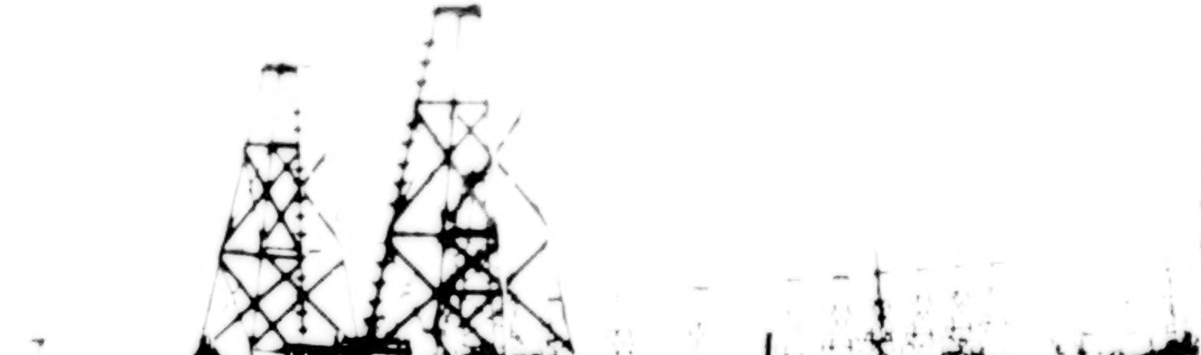
History of Offshore Petroleum Development

The earliest offshore oil production in the United States was developed off Summerland, California, in 1896 (Figure 7). The offshore portion of the field was an extension of an onshore discovery that had been made before 1894. The offshore wells were drilled from wooden piers extending out from the shoreline. In all, more than 400 shallow wells were drilled and completed at a depth of about 600 feet.

The discovery of the Creole field in 1938 in the Gulf of Mexico, 1½ miles from shore in 26 feet of water, marked the petroleum industry's first successful venture into open, unprotected waters. In November 1947, a discovery was made in Ship Shoal Block 32 off the Louisiana coast, 12 miles from shore in water 16 feet deep. This well was the first offshore well to be drilled out of sight of land. It was also the first offshore well drilled from a mobile platform, thus initiating the technology that has subsequently been utilized to drill more than 20,000 offshore oil and gas wells in the waters of the United States.

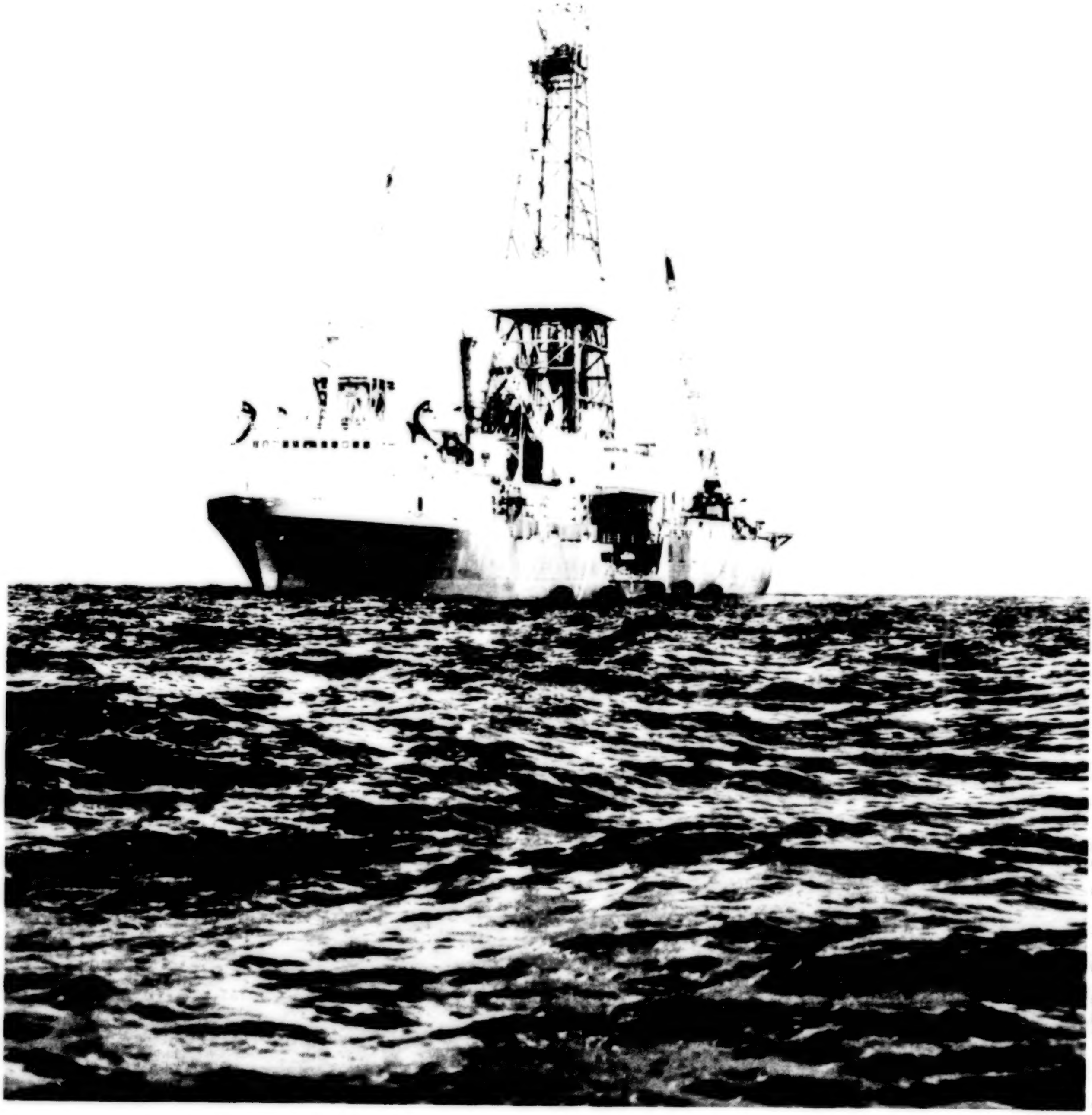
As the search for oil and gas moved further offshore and into deeper waters, industry has continued to expand drilling and production technology. The technology used for exploration and production of petroleum in deeper water illustrates these advancements. Conventional steel-jacketed production platforms stand in as much as 850 feet of water off southern California and in 1,025 feet of water off the Louisiana coast. In 1983, a compliant guyed-tower production platform was installed in 1,000 feet of water

110 miles southeast of New Orleans, Louisiana. In 1984, the drillship, Discoverer Seven Seas, drilled an exploratory well in 6,952 feet of water off the coast of New Jersey (Figure 8). In the often ice-bound waters of the arctic, drilling units have evolved from the single use artificial gravel islands to specially designed multi-use caisson-retained islands and ice-resistant mobile units of more conventional design.



Courtesy of California Historical Society and American Petroleum Institute Photographic and Film Services

FIGURE 7. Summerland Oil Field, California, in the late 1800's



Courtesy of Phillips Petroleum Co. & American Petroleum Institute.

FIGURE 8. Discoverer Seven Seas drillship (Atlantic)

Chapter 3. OCS Leasing Framework and Procedures

The 5-Year Program and Leasing Schedule

A leasing schedule is the framework used to delineate the timing and planning procedures for individual sale areas.

Section 18 of the OCS Lands Act, which was added by the amendments of 1978, requires the Secretary of the Interior to prepare and maintain an OCS oil and gas leasing program which consists of both a schedule of lease sales for a 5-year period plus policies regarding the size, location, and timing for those sales.

The following are the factors upon which the analysis which supports the 5-year program must be made as set forth in section 18(a)(2) of the OCS Lands Act, as amended in 1978:

- existing information concerning the geographical, geological, and ecological characteristics of such regions;
- an equitable sharing of developmental benefits and environmental risks among the various regions;
- the location of such regions with respect to, and the relative needs of, regional and national energy markets;
- the location of such regions with respect to other uses of the sea and seabed, including fisheries, navigation, existing or proposed sealanes, potential sites of deepwater ports, and other anticipated uses of the resources and space of the OCS;
- the interest of potential oil and gas producers in the development of oil and gas resources as indicated by exploration or nomination;
- laws, goals, and policies of affected States which have been specifically identified by the Governors of such States as relevant matters for the Secretary's consideration;
- the relative environmental sensitivity and marine productivity of different areas of the OCS; and
- relevant environmental and predictive information for different areas of the OCS.

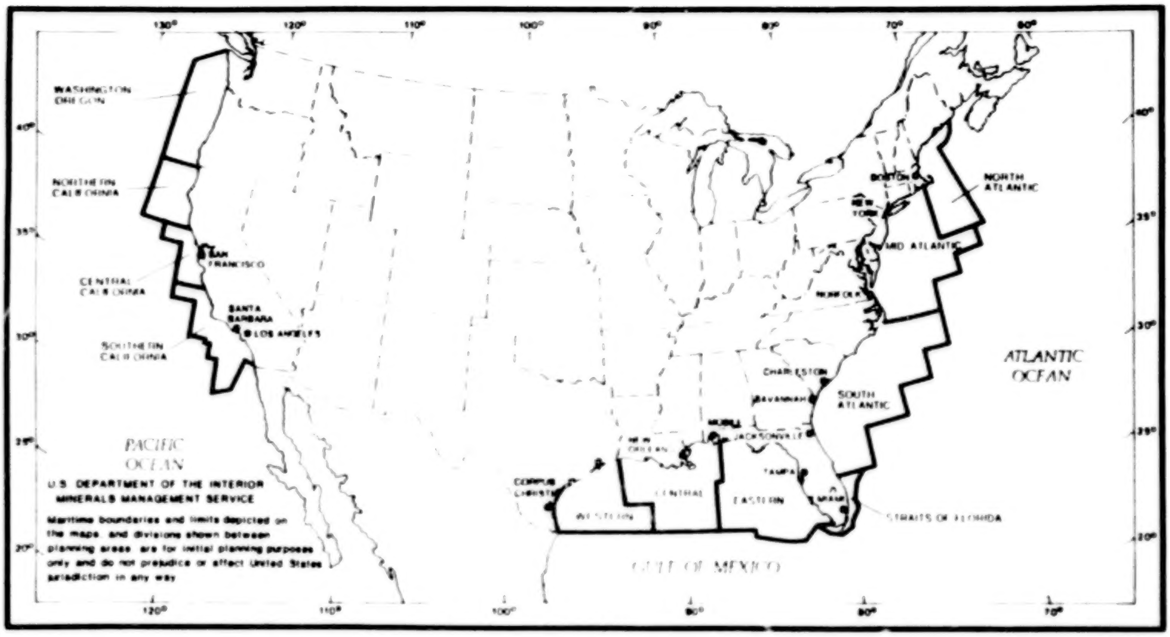
The schedule is continually being updated and revised within the Department of the Interior. Key considerations in this process are the three objectives of the leasing program: (1) orderly resource development, (2) protection of the environment, and (3) receipt of fair market value from the sale of leases and the production of oil and gas.

The following factors influence what areas are selected for the schedule:

- initial assessments of oil and gas potential as estimated by both the Resource Evaluation Program and industry;
- environmental resources that might be affected by OCS development;
- the availability of technology; and
- the proximity to markets.

For the scheduling of sales, the OCS is divided into sections called planning areas. These planning areas are large, contiguous areas, usually embracing several million acres, designating specific regions of the OCS, i.e., North Atlantic Planning Area, Eastern Gulf of Mexico Planning Area, Navarin Basin (Alaska) Planning Area, Beaufort Sea (Alaska) Planning Area. Currently the OCS is divided into 26 planning areas (see Figures 9 and 10). These planning areas are subdivided into 3-mile by 3-mile blocks also called tracts.

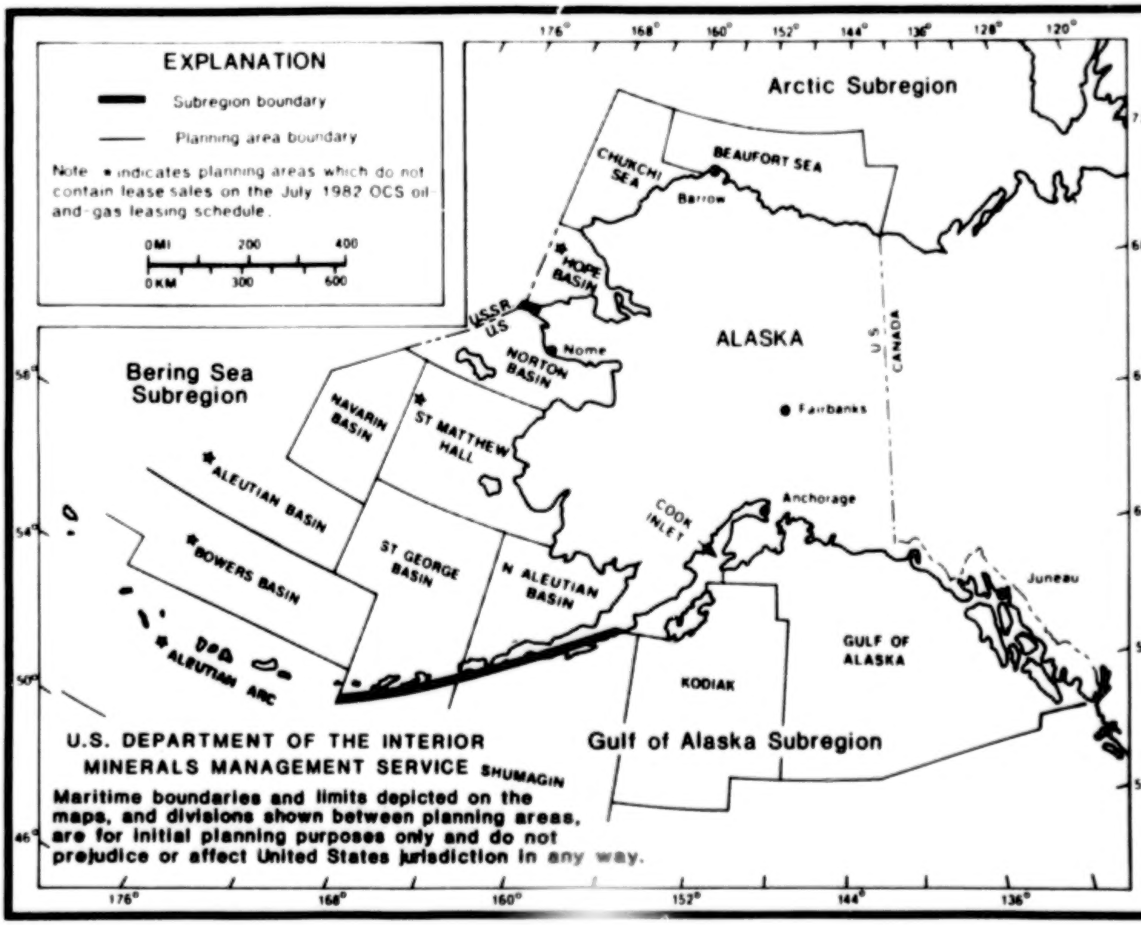
Since the first lease sale, held in the Gulf of Mexico in 1954, through 1984, the DOI has offered 61,834 tracts totaling 332.6 million acres for lease and 7,418 tracts, totaling 38.2 million acres have been leased for a net total bonus of $51.4 billion dollars. An additional $25.1 billion have been collected during this period in royalties and rental fees.



U.S. DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE

Maritime boundaries and limits depicted on the maps, and divisions shown between planning areas, are for initial planning purposes only and do not prejudice or affect United States jurisdiction in any way.

FIGURE 9. OCS planning areas — lower 48 states



Note: * indicates planning areas which do not contain lease sales on the July 1982 OCS oil-and-gas leasing schedule.

U.S. DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE

Maritime boundaries and limits depicted on the maps, and divisions shown between planning areas, are for initial planning purposes only and do not prejudice or affect United States jurisdiction in any way.

FIGURE 10. OCS planning areas — Alaska

Leasing Procedures

Before discussing the actual functions of the Resource Evaluation Program in detail, it is necessary to discuss the various milestones to be met as a lease sale proceeds to fruition. These milestones are identified in Figure 11.

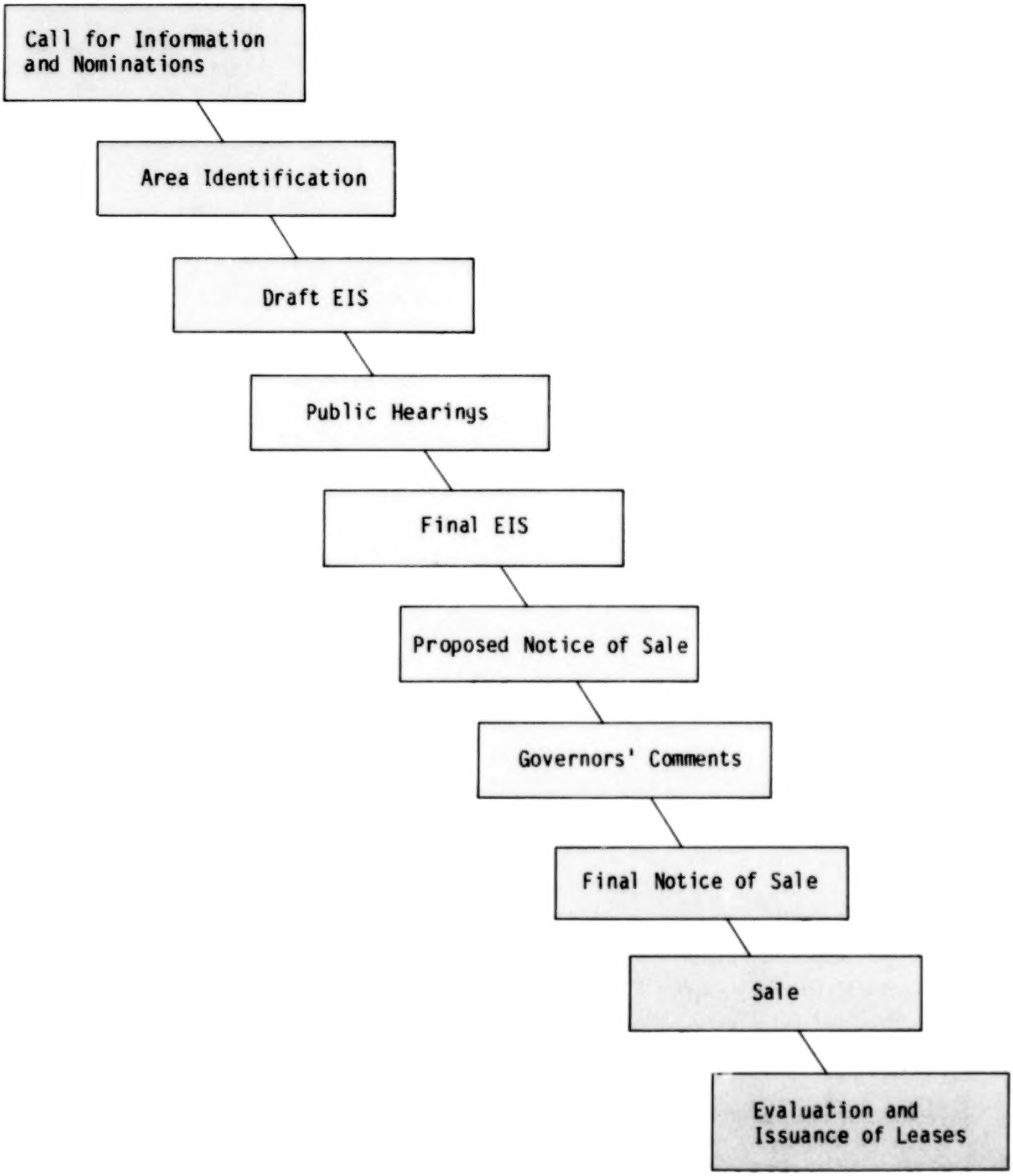


FIGURE 11. Leasing procedures and milestones

1. Call for Information and Nominations—Once a planning area is listed on the 5-year leasing schedule as a potential area for a lease sale, the first formal step in the sale process is a Call for Information and Nominations. The Call is a notice published in the *Federal Register*. It informs the public of the potential area under consideration for oil and gas leasing and solicits comments from States and all interested parties on areas which should receive special attention and analysis. The Call includes a map defining that part of the planning area most favorable for the generation and accumulation of hydrocarbons ("area of hydrocarbon potential" to be discussed later). Comments on the Call are due 45 days after it is published.

2. Area Identification—After the comment period for the Call for Information and Nominations closes, the MMS develops and evaluates options for Area Identification. This step involves identifying blocks which should be further studied and considered for offering. In general, all blocks which show hydrocarbon potential or are of interest to industry are included in the proposal for further study if it can be shown that there is a balance between their energy values and potential environmental harm or conflict with other uses of the seabed. The DOI strives to resolve as many issues as possible during area identification in order to prevent unnecessary conflicts throughout the remainder of the presale process.

3. Draft Environmental Impact Statement/Public Hearings/Final Environmental Impact Statement—The National Environmental Policy Act (NEPA) requires the preparation of a detailed Environmental Impact Statement (EIS) before conducting any Federal action which could significantly affect the quality of the human environment. Before a lease sale, the DOI prepares a draft EIS and holds a public hearing.

The draft EIS includes the following:

- a description of the lease sale proposal, including the estimated oil and gas resources, and a projection of the exploration and development activity that might occur;
- reasonable alternatives to the leasing proposal;
- a description of the existing environment;
- a detailed analysis of possible effects on the environment, including cumulative effects;
- a description of the assumptions upon which the analysis is based;
- potential mitigating measures;
- any unavoidable adverse environmental effects;
- the relationship between short-term uses and long-term productivity;
- any irreversible or irretrievable commitment of resources; and
- the records of consultation and coordination with others in preparation of the document.

It may also describe the technology necessary for exploration, development, and production of the proposed lease sale area as well as possible onshore socioeconomic effects.

The comment period for the draft EIS is 60 days. However, no sooner than 30 days after publication, one or more public hearings are held in the vicinity of the proposed sale area. Any oral and written comments on the draft EIS are considered in the preparation of the Final EIS which comes out about 3 to 5 months after the public hearing.

4. Proposed Notice of Sale/Governors Comments—The proposed Notice of Sale is a public announcement published in the *Federal Register* about a month after the final EIS is made available. The notice identifies the blocks that are available for lease, stipulations and/or mitigating measures pertaining to all or specific blocks, proposed bidding systems and lease terms, and other information useful to potential lessees. Any member of the public may submit comments in response to a proposed Notice of Sale. However, it is specifically sent to the Governors of affected States, who have 60 days to comment on the size, timing, location, and terms of the proposed lease sale.

5. Final Notice of Sale—After receiving comments from the Governors of the affected States, on the size, timing, or location of a proposed lease sale, the Secretary must provide for a reasonable balance between the national interest and the well-being of an affected State. The rationale for accepting or not accepting recommendations of the Governors must be communicated to them in writing.

If the Secretary decides to proceed with the lease sale after considering comments from the Governors and any pertinent new information, the Secretary issues a final Notice of Sale. The Notice of Sale includes the date, time, and place of the sale; blocks available for lease; stipulations and other mitigating measures; bidding systems and lease terms; and other pertinent information. It is published in the *Federal Register* at least 30 days before the sale date.

6. Sale—Lease sales are open to the public and are conducted by the appropriate Regional Director, usually in the city in which the OCS regional office is located. Sealed bids submitted by qualified bidders are publicly opened and read. Qualified bidders may submit bids on any block or bidding unit listed in the final Notice of Sale. Each bid submitted must contain payment of 1/5 of the amount of the cash bonus bid. The minimum acceptable bid for any tract is generally $150 per acre or $371 per hectare or portion thereof unless stated otherwise in the Notice of Sale. The bids are checked for technical and legal adequacy on the day of the public reading to determine if the bidder has complied with all applicable regulations.

7. Postsale Evaluation—Immediately after the lease sale the MMS, through the Resource Evaluation Program, determines whether a bid shall be accepted through implementation of a two-phase process.

Phase 1 is designed to identify those tracts where bidding competition is sufficient to assure receipt of fair market value or where data does not indicate that an economically viable prospect is present. This process is normally completed within 3 days of the bid opening.

Those tracts with high bids not accepted in Phase 1 receive further evaluation in Phase 2 where detailed estimates of the economic value of the oil and gas resources on each tract are prepared. The high bids are then compared to those estimates of resource economic value.

The regulations state that the Regional Director must accept or reject bids within 90 days after they are opened. Before any bid is accepted, the results of the sale are reviewed by the Attorney General and the Federal Trade Commission to determine if awarding a lease would create a situation inconsistent with the antitrust laws. Any bid not accepted within the prescribed time is considered rejected.

Chapter 4. Geologic and Geophysical Data Acquisition, Evaluations, and Analyses

As previously mentioned, early in the leasing process, scientific data and information must be gathered and analyzed to determine the potential of entire planning areas. As the leasing process for a particular sale proceeds, data are continually acquired and analyzed to determine the resource potential for the specific sale area within the planning area, and finally for the resource economic evaluation of prospects within that specified area.

The major responsibilities of the Geologic and Geophysical Data Acquisition, Evaluations, and Analyses component are data acquisition, production of areawide maps and analyses, and production of tract- and prospect-specific maps and analyses for resource economic evaluations. These activities are essential for completing major milestones in the leasing and evaluations process.

Collection of Geologic and Geophysical Data

The only positive way of knowing whether an area contains petroleum is to drill one or more wells, but a number of geologic and geophysical techniques have been developed and refined over the years to assist in predicting whether there may be petroleum in an area. With these techniques, attempts are made to infer: (1) whether the requisite geologic conditions for petroleum occurrence exist, (2) where reservoirs are located, and (3) the size of the reservoirs and the probable volumes of petroleum that they may contain.

Most of the information used by both the Federal Government and industry to estimate or infer the oil and gas potential of an area is acquired by G&G surveys. A considerable amount of this information is collected by lessees or under prelease exploration permits issued by the MMS to specialized data-collection firms that sell or furnish the information to oil companies and to the DOI. Processing and approval of exploration permits are responsibilities of the Resource Evaluation Program and include: reviewing of applications for permits and agreements for OCS geologic or geophysical scientific research or exploration for mineral resources; issuing permits and agreements, including terms, conditions, and stipulations; monitoring permit activity; and corresponding with prospective permittees. This process is outlined in Figure 12. After data have been collected by permittees, the MMS selectively acquires that data which are needed to augment the existing data base.

Industry uses these G&G data to determine the areas having potential for oil and gas production. These areas are then recommended to the MMS in response to the Call for Information and Nominations. Oil companies also use these data for preparing bids for lease sales. Prelease and postlease use of these data by MMS is shown in Figure 13. The MMS also acquires data that have been collected for scientific research activities for which an approved permit or filing of notice is required.

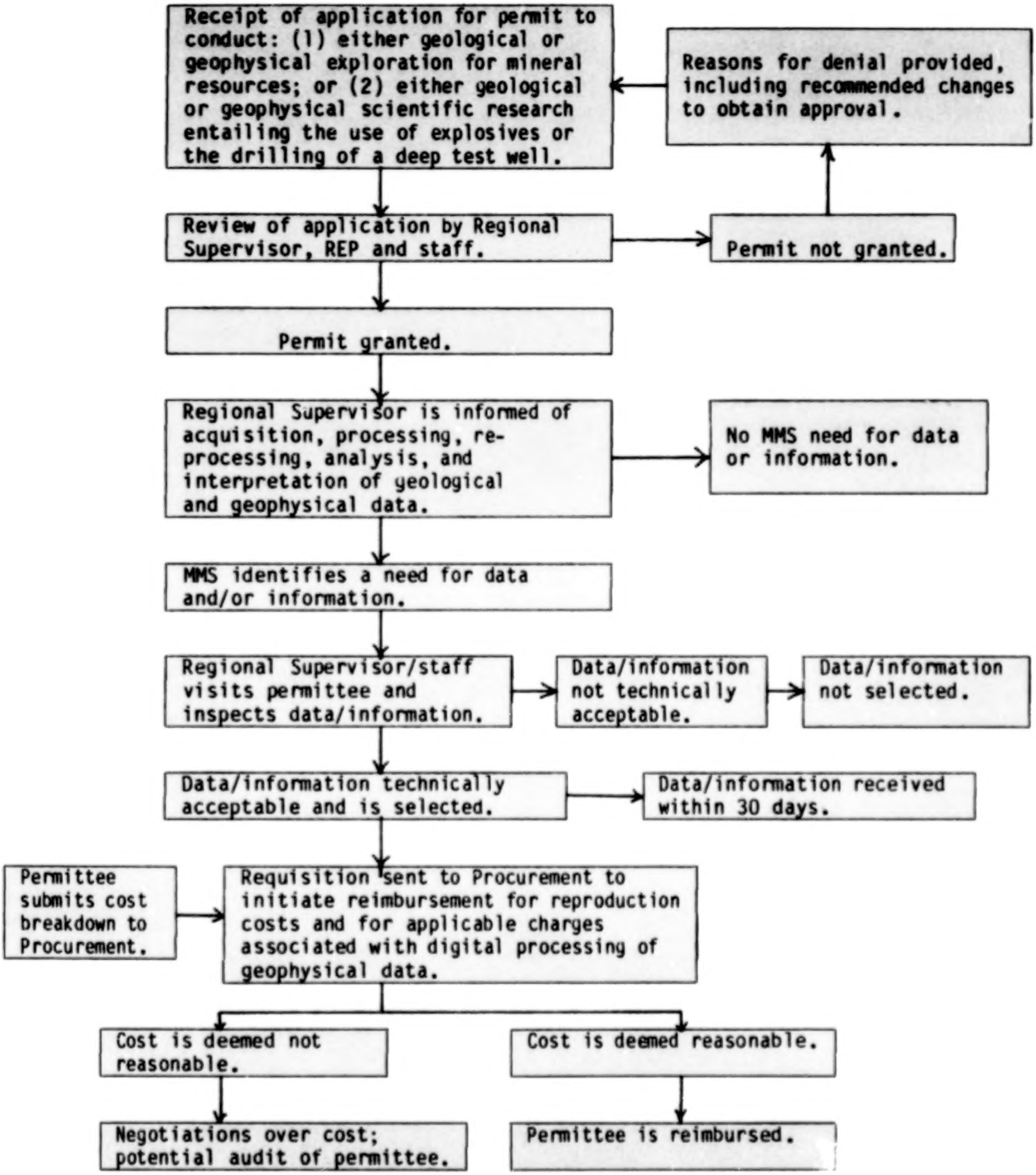

Receipt of application for permit to conduct: (1) either geological or geophysical exploration for mineral resources; or (2) either geological or geophysical scientific research entailing the use of explosives or the drilling of a deep test well.
Reasons for denial provided, including recommended changes to obtain approval.
Review of application by Regional Supervisor, REP and staff.
Permit not granted.
Permit granted.
Regional Supervisor is informed of acquisition, processing, reprocessing, analysis, and interpretation of geological and geophysical data.
No MMS need for data or information.
MMS identifies a need for data and/or information.
Regional Supervisor/staff visits permittee and inspects data/information.
Data/information not technically acceptable.
Data/information not selected.
Data/information technically acceptable and is selected.
Data/information received within 30 days.
Permittee submits cost breakdown to Procurement.
Requisition sent to Procurement to initiate reimbursement for reproduction costs and for applicable charges associated with digital processing of geophysical data.
Cost is deemed not reasonable.
Cost is deemed reasonable.
Negotiations over cost; potential audit of permittee.
Permittee is reimbursed.

FIGURE 12. MMS acquisition of geological and geophysical data and information as a condition of permit and regulations

Common Depth Point (CDP)

Areawide Geologic Mapping

- Geology report
- Resource estimates
- Identify areas of hydrocarbon potential
- Identify prospects
- Exploration and Development (E&D) Report
- Area identification
- E&D for alternatives
- Updating regional resource estimates

Tract-Specific Mapping

- Tract evaluation
- Bidding system design
- Resource estimates for Secretarial Issue Document and deletion options
- Section 8(g) determinations
- Bid acceptance and rejection determinations
- Leased lands resource estimates

High-Resolution Data

Areawide Geologic Mapping (Prelease)

- Geology report
- Identify shallow geologic features to develop stipulations, etc.
- Summary for E&D report

Tract-Specific Mapping (Postlease)

- Exploration plans
- Development and production plans
- Site-specific shallow hazards analysis
- Cultural resources

FIGURE 13. MMS uses for marine seismic data

1. Geophysical Surveys—Geophysics is the application of the principles of physics at or near the surface of the earth to determine the geology beneath the surface. General seismology is that branch of geophysics concerned with the study of earthquakes and the measurement of the elastic properties of the earth. In exploration seismology, energy is transmitted into the earth and the recorded reflections provide the subsurface information about the delineation of geological structures.

By measuring from the earth's surface the two-way travel time of seismic waves through various rock formations, as shown in Figure 14, data can be collected regarding the thickness and total depth of various layers of rock and the probable location and existence of structural features such as reefs, salt domes, folds and faults, and stratigraphic traps. Analysis of the shallow layers identifies potentially hazardous conditions such as surface faulting, potential slope failure areas, or shallow gas accumulations. Information about the deeper layers is used primarily for evaluating the petroleum resource potential.

The most common sources of energy for offshore seismic prospecting are air or gas guns which generate seismic waves without the use of explosives. An array of various size guns provides sufficient energy to penetrate over 20,000 feet of formation in most areas. The underwater geophones that detect the reflected seismic energy are sensitive instruments enclosed in a cable which is towed behind a ship. Wires carry the information to the recorders aboard ship. The ship-borne equipment records the seismic signals on magnetic tape in digital format. These field data are processed in a digital computer to eliminate unwanted"noise"or random energy. After the data have been processed to obtain maximum quality, they are displayed in the form of a vertical cross-section. (See Figure 15.)

2. Geologic Surveys—Geological surveying on the OCS consists of bottom sampling, shallow coring, and deep stratigraphic tests. These data are useful in determining the general geology of an area and whether the right types of rocks exist for petroleum formation and accumulation.

- Bottom samples are obtained by dropping a weighted tube to the ocean floor and recovering it with an attached wire line. Depending upon the nature of the ocean floor, penetration is normally limited to a few tens of feet. Bottom samples can also be obtained from dredging.
- Shallow coring is performed by conventional rotary drilling equipment to obtain a near-surface sample of the rocks of the seabed. Choice of location is carefully controlled to avoid any shallow (geological and manmade) hazards, for example, faults or environmentally sensitive areas. Penetration is limited to 50 feet of consolidated rock.

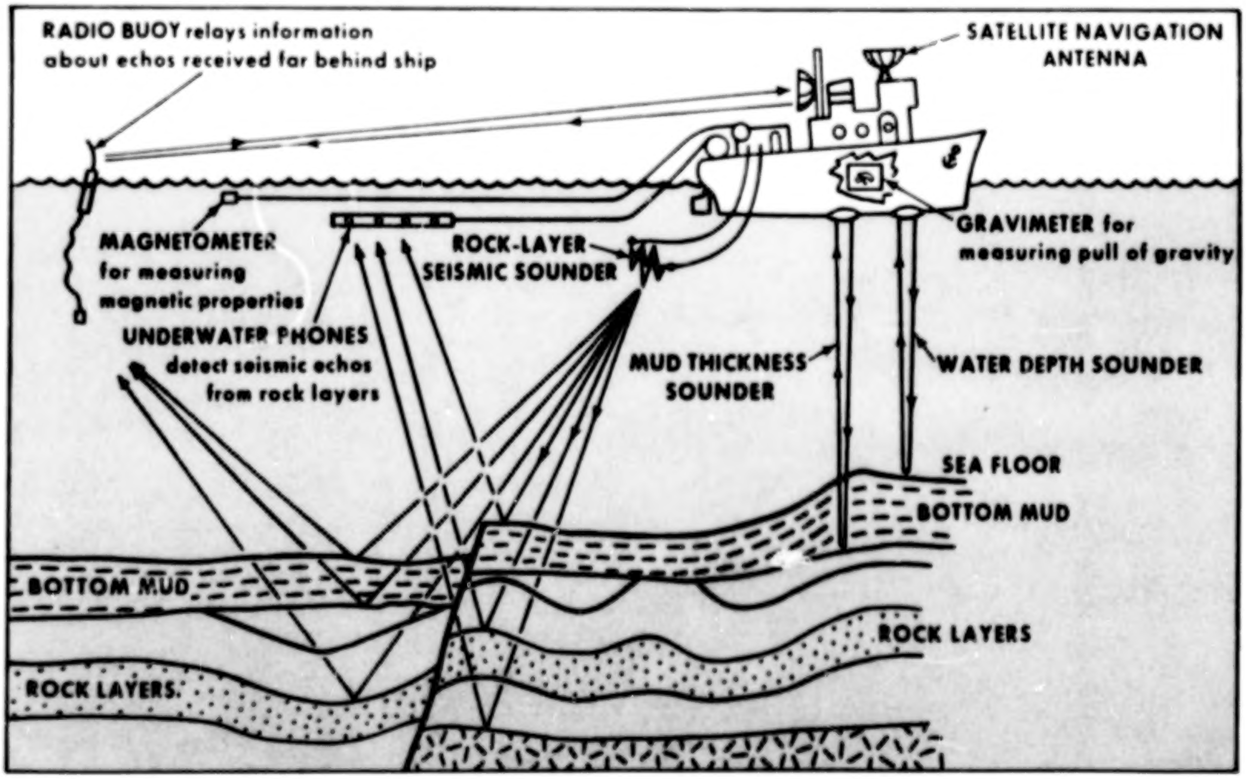

RADIO BUOY relays information about echos received far behind ship
SATELLITE NAVIGATION ANTENNA
MAGNETOMETER for measuring magnetic properties
ROCK-LAYER SEISMIC SOUNDER
GRAVIMETER for measuring pull of gravity
UNDERWATER PHONES detect seismic echos from rock layers
MUD THICKNESS SOUNDER
WATER DEPTH SOUNDER
SEA FLOOR
BOTTOM MUD
BOTTOM MUD
ROCK LAYERS
ROCK LAYERS

FIGURE 14. Schematic showing marine seismic prospecting method

- In any planning area, deep stratigraphic test wells, commonly known as continental offshore stratigraphic test (COST) wells, can be drilled to determine the geological character of rock strata. The location of such wells is carefully controlled by a permit issued by the MMS. These tests, which may be more than 20,000 feet deep, provide information that can be used by the Government and industry to evaluate tracts to be offered in a lease sale. Basically, an operator sets up a consortium of other companies where drilling costs are shared. The wells are drilled in accordance with MMS regulations. All stratigraphic tests must be completed 60 days before the sale and the information is released to the public 10 years after completion of the well or 60 calendar days after the issuance of the first oil and gas lease within 50 miles (92.6 km) of the well site. The general location of these COST wells is shown on Figures 16 and 17.

Production of Regional Geologic and Geophysical Maps and Analyses

The primary objective of the acquisition and analysis of G&G data is the development of maps identifying areas favorable for the accumulation of hydrocarbons. This is done by incorporating the data acquired through G&G surveys plus analyzing technical and scientific data and information to develop a basic knowledge of the geologic history of the sale area and its effects on hydrocarbon or strategic/critical minerals generation, distribution, and accumulation within the planning area. This information provides the basis for a geology report and associated maps that describe the geology, probability of hydrocarbon occurrence, resource potential, and potential shallow geologic hazards of the planning area.

1. Geology Report—The Geology Report includes information concerning the regional geology, petroleum geology, environmental geology, and regional geohazards for a particular sale in a particular planning area. This report generally precedes the Call for Information and Nominations by a maximum of 8 months. The data, information, and analyses in the Geology Report are updated and used in the leasing process as input to the EIS as well as to other MMS and department decision and option documents. The maps and information also provide support for analyses carried out in the Area Identification and prospect evaluation process. Once an initial Geology Report is prepared for a planning area, it is updated with new or additional data, as appropriate, for succeeding sales in the same planning area.

The report consists of the following specific sections:

- *Regional Geology*
- Geology and geologic history of the planning area
- Regional stratigraphy and geologic trends (include cross-sections)
- Regional structure and major structural features
- Maps of basin outline, major structural trends and contours, isopachs of sedimentary rocks, and other appropriate maps

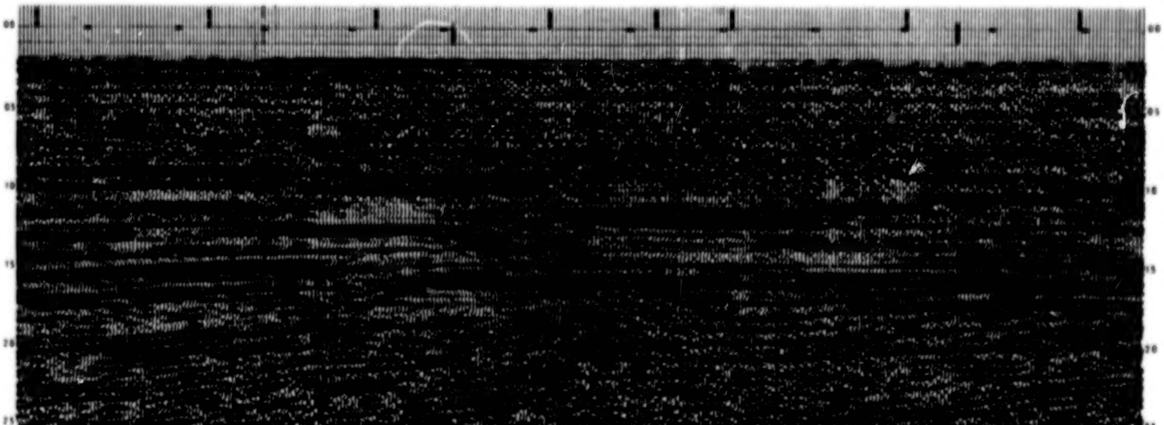


FIGURE 15. Processed Seismic Reflection Data

Petroleum Geology

- Exploration history of the area
- Source rocks and inferred maturation history
- Probable traps, reservoirs, and seals
- Oil and gas fields and major exploratory wells in the area

Environmental Geology and Geohazards

- Shallow geologic features that could pose a hazard
- Seismic risks and hazards
- Distribution of bottom sediments and bedrock outcrops
- Identification of oil and gas seeps
- Maps of bathymetry, isopachs of unconsolidated sediment and bedrock outcrops, geohazards, and other appropriate maps

2. Area of Hydrocarbon Potential Map—Approximately 2 months before the Call for Information and Nominations the Area of Hydrocarbon Potential must be identified. The regional office prepares a map identifying those portions of the planning area having various ranges of potential. This map designates zones of high, moderate, and low potential, relative to that planning area. The map may also include a zone of no potential or unknown potential. In some cases the geology may be so complex that zones cannot be separated out, thus two zones may be combined; i.e., high and moderate potential. To initiate action on a lease sale, it is necessary to determine which specific areas within the entire planning area have potential for oil and gas accumulation. This map of the Area of Hydrocarbon Potential (AHP) serves as a part of the Call for Information and Nominations. When the Call is issued, the AHP map is attached, showing one combined zone, not separate zones, allowing the public and industry to recommend areas of interest and concern both within and beyond those identified.

This information represents a significant refinement to that contained in the Geology Report.

3. Recommendations for Area Identification—A significant step in the leasing decision process is the identification of that portion of the planning area that is proposed to be offered for lease. Identification is based, in part, on industry's interest and MMS' determination of the area's hydrocarbon potential.

Area Identification occurs approximately 3-4 months after the Call for Information and Nominations is issued. In response to the Call, industry, the public, and other interested parties submit information to the MMS on what areas within the planning area should or should not be included in the proposed sale.

The information and knowledge of the hydrocarbon potential in the planning area is combined with information on industry interest and priorities and then weighed against environmental, economic, and defense concerns to identify the specific area to be included in the proposed sale. This area then becomes the focus of the analysis in the EIS.

Production of Tract- and Prospect-Specific Maps and Analyses

After Area Identification, the emphasis of the Resource Evaluation Program shifts to more detailed mapping and analyses needed to estimate the resource potential of individual prospects within the area of-

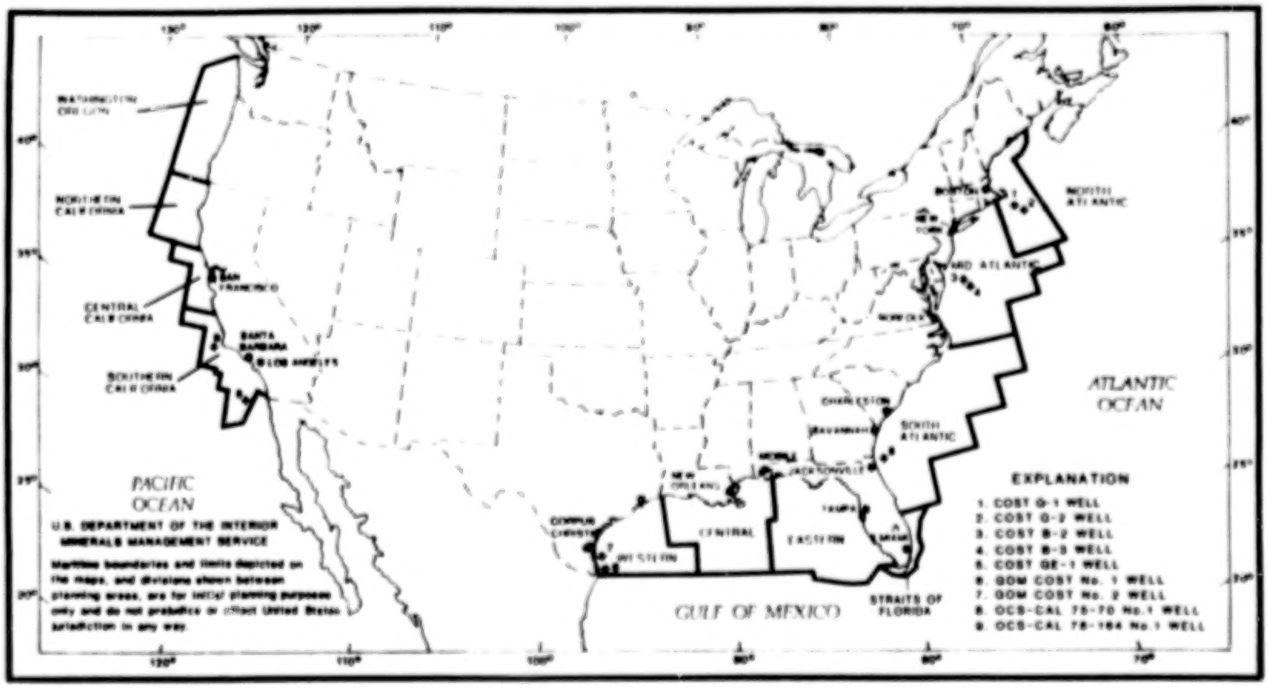


FIGURE 16. Location of COST wells — lower 48 states

fered for sale. These prospect-specific data, maps, and analyses are also used to determine parameters for postsale bid analyses. Industry will collect additional data for the specific sale area identified. MMS will acquire any of these data that it feels will supplement its analysis of the resource potential of the sale area.

In a frontier area, where no previous work has been done, a team of geologists and geophysicists is assigned to interpret seismic data, which have been collected, and analyze any COST well data that exist. In some cases there may be only onshore well data available or no well data at all in the area. Where onshore well data are available, it may be possible to determine which formations have good source and reservoir rocks and try to extend those formations with the aid of seismic data to the OCS. Where well data are available either onshore or offshore, the geologist can furnish to the geophysicist the depth, number, and thickness of potential reservoir beds, along with structural details such as faults or intrusive penetrations.

The geophysicist studies all seismic sections covering the area looking at depth and continuity of reflections, dip and convergence of reflecting beds, and the position and determination of faults and intrusions in an attempt to identify geologic structures or stratigraphic traps. Two horizons or formations are usually mapped by the geophysicist at or near productive zones found in any nearby wells, if available, or otherwise prospective stratigraphic trends.

After completing the evaluations and analyses for a specific lease sale, the prospect-specific analyses are incorporated into the regional maps and analyses, and the process is repeated for the next sale. An example of a correlated seismic section and a map derived from that section and other seismic sections is shown in Figures 18 and 19.

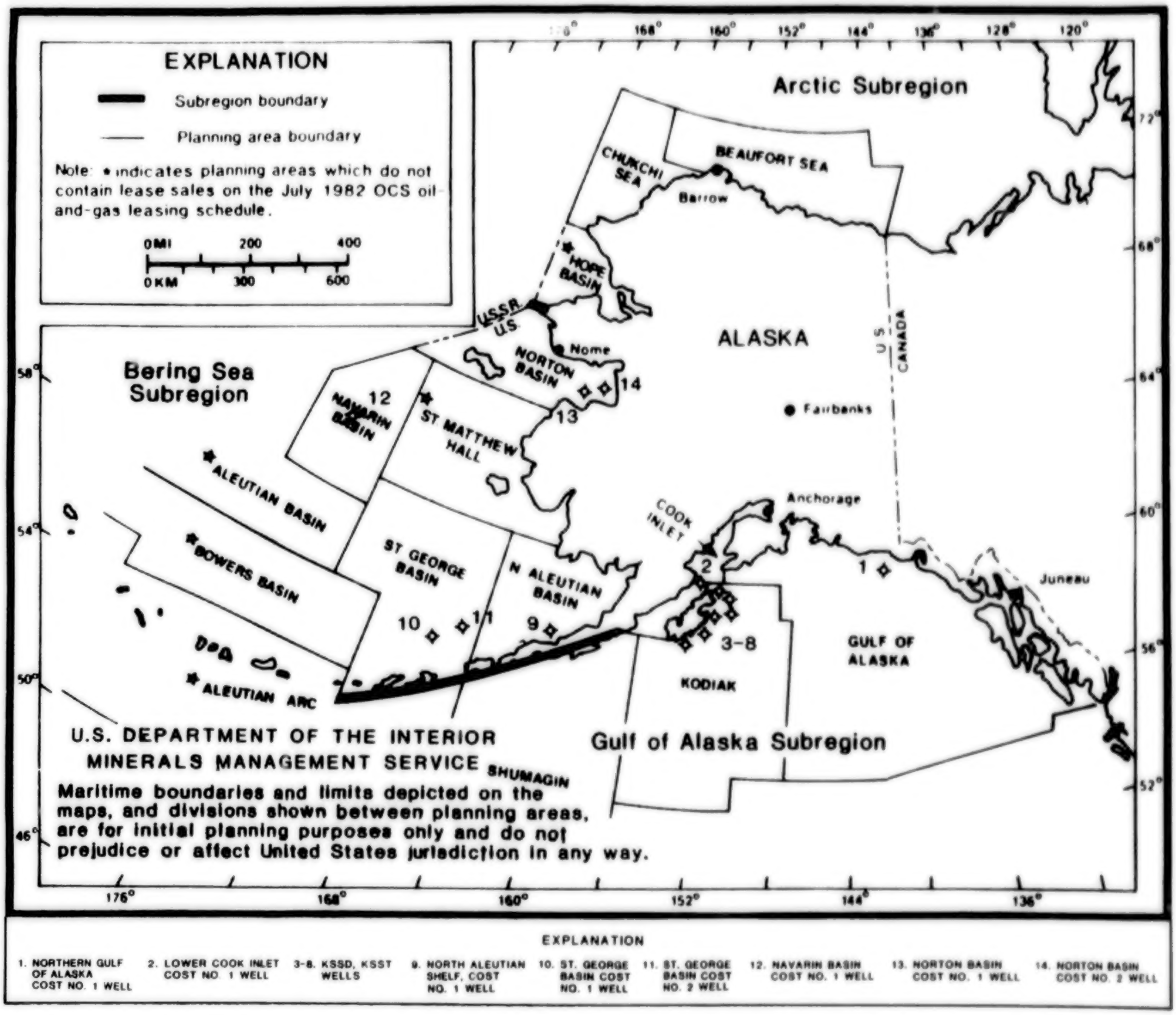
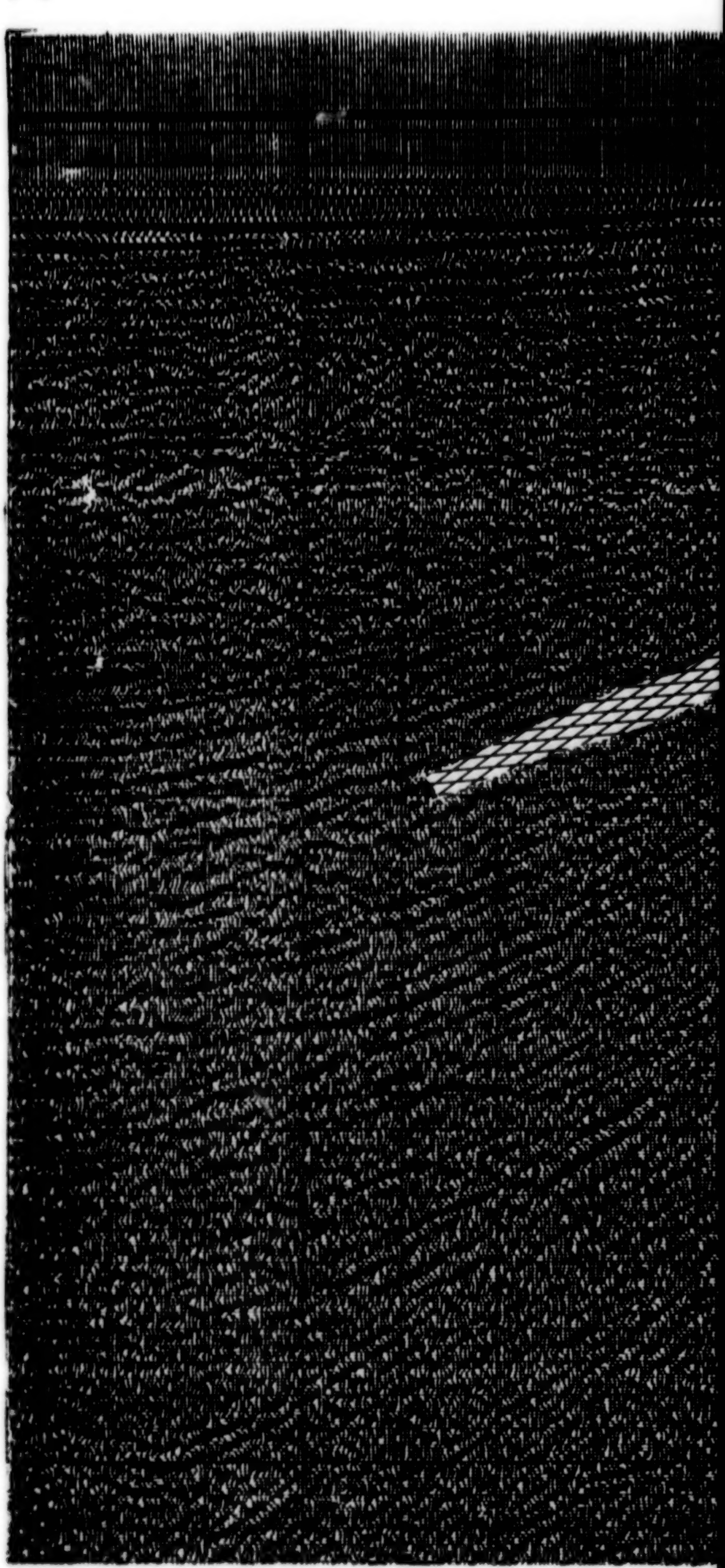

EXPLANATION
Subregion boundary
Planning area boundary
Note: ✱ indicates planning areas which do not contain lease sales on the July 1982 OCS oil-and-gas leasing schedule.
0 MI
200
400
0 KM
300
600
Arctic Subregion
BEAUFORT SEA
CHUKCHI SEA
Barrow
HOPE BASIN
U.S.S.R.
U.S.
Nome
NORTON BASIN
ALASKA
U.S.
CANADA
Fairbanks
Bering Sea Subregion
NAVARIN BASIN
ST MATTHEW HALL
ALEUTIAN BASIN
BOWERS BASIN
ST GEORGE BASIN
N ALEUTIAN BASIN
ALEUTIAN ARC
COOK INLET
Anchorage
Juneau
GULF OF ALASKA
KODIAK
SHUMAGIN
Gulf of Alaska Subregion
1
2
3-8
9
10
11
12
13
14
168°
160°
152°
144°
136°
128°
120°
176°
72°
68°
64°
60°
56°
52°
58°
54°
50°
46°
U.S. DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE
Maritime boundaries and limits depicted on the maps, and divisions shown between planning areas, are for initial planning purposes only and do not prejudice or affect United States jurisdiction in any way.
EXPLANATION
1. NORTHERN GULF OF ALASKA COST NO. 1 WELL
2. LOWER COOK INLET COST NO. 1 WELL
3-8. KSSD, KSST WELLS
9. NORTH ALEUTIAN SHELF, COST NO. 1 WELL
10. ST. GEORGE BASIN COST NO. 1 WELL
11. ST. GEORGE BASIN COST NO. 2 WELL
12. NAVARIN BASIN COST NO. 1 WELL
13. NORTON BASIN COST NO. 1 WELL
14. NORTON BASIN COST NO. 2 WELL

FIGURE 17. Location of COST wells—Alaska

A



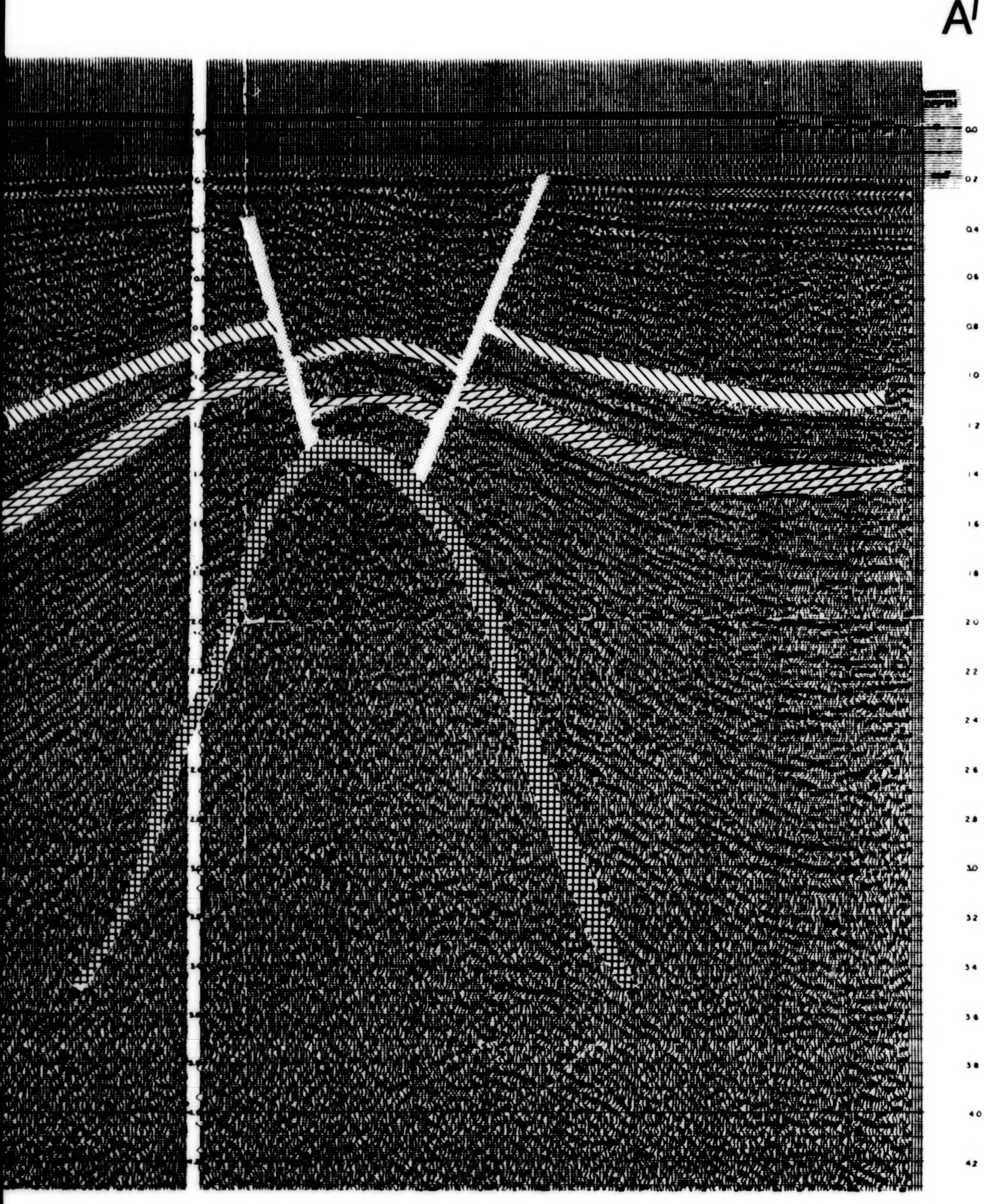


FIGURE 18. Correlated seismic section

Procedures Under Section 8(g) of the Outer Continental Shelf Lands Act

Section 8(g)(1) of the OCS Lands Act states:

At the time of soliciting nominations for the leasing of lands within 3 miles of the seaward boundary of any coastal State, the Secretary shall provide the Governor of such State—

1. an identification and schedule of the areas and regions proposed to be offered for leasing;
2. all information concerning the geographical, geological, and ecological characteristics of such regions;
3. an estimate of the oil and gas reserves in the areas proposed for leasing; and
4. an identification of any field, geological structure, or trap located within 3 miles of the seaward boundary of such coastal State.

In fulfilling the requirements of section 8(g)(1), the Governor of each affected coastal State receives the following specific information:

For 8(g)(1)(A)—a copy of the map and description of the Call for Information and Nominations (Call) and the current 5-year leasing schedule with the proposed sale highlighted.

For 8(g)(1)(B)—the most recent Geology Report and the latest EIS for the area proposed in the Call.

For 8(g)(1)(C)—a copy of the most recent reserves report for the area described in the Call.

For 8(g)(1)(D)—a list of tracts that the MMS believes to have a field, geological structure, or trap within 3 miles seaward of the Federal/State boundary of the affected State.

At the time of Area Identification, a second letter to the Governors is sent providing them with information as to what tracts within 3 miles of the State seaward boundary are in the sale and if any of those tracts have a common structure with tracts in State waters. This letter will include a listing of tracts that do have common structures, tracts that do not, and tracts where it has not been determined.

Minerals Management Service/University of Texas Cooperative Agreement

In an effort to broaden the base of data and information on the offshore, the MMS entered into a cooperative agreement with the Texas Bureau of Economic Geology (BEG), University of Texas at Austin, in September 1983. The BEG acts as a central contact between the MMS and the Geological Surveys of coastal States and monitors multidiscipline, scientific activities conducted by the Surveys for the MMS. The two general areas that the cooperative effort addresses are: (1) strategic/critical minerals, and (2) geologic studies relating to hydrocarbon resources.

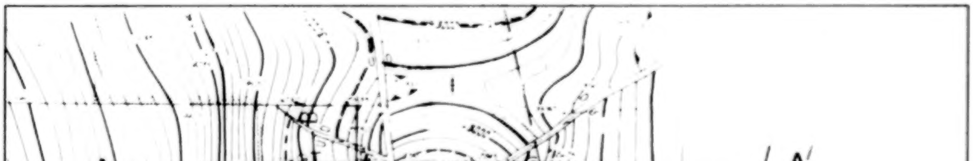


FIGURE 19. Map derived from correlated seismic section in figure 18

Chapter 5. Resource Economic and Engineering Evaluations and Analyses

Much of the data and analyses derived under the Geologic and Geophysical Data Acquisition, Evaluations, and Analyses component is combined with economic and engineering data to produce information that is essential to completing major steps in the leasing process.

The objectives of the Resource Economic and Engineering Evaluations and Analyses component are to: (1) develop estimates of technologically and economically recoverable OCS mineral resources for planning areas and for potential lease sale areas to be used throughout the leasing decision process; (2) analyze, develop, and design economic and engineering parameters on both a lease sale and a tract-specific basis to be used in assessing environmental impacts and in determining bid adequacy; and (3) develop economic and engineering methodologies and studies for the leasing process. Fundamental to accomplishing these objectives is the design, maintenance, and update of advanced computer models, automated data processing (ADP) systems, and data bases for economic and engineering analyses that are a basic part of the overall OCS program.

These analyses provide information to the annual review of the 5-year schedule, and any subsequent revisions to the schedule, as required by the OCS Lands Act Amendments. Additionally, this program provides reliable and comprehensive information on the availability of offshore oil and gas resources to meet future energy supply emergencies.

Development of Resource Estimates for Planning Areas

Following the acquisition of G&G data, the initial step in this process is to derive resource estimates for a planning area. Economic and engineering analyses, supplemented by G&G analyses, are carried out to develop estimates of technologically and economically recoverable resources for planning areas, lease sale proposals and alternatives, deletion options, and the OCS Information Program. Those initially developed for planning areas are updated, as appropriate, with new or additional data for succeeding sales in the same planning area.

Planning area resource estimates are developed for:

- Biennial reports to Congress containing estimates of undiscovered recoverable oil and gas resources on the OCS as required by section 606 of the OCSLAA.
- Use in the annual review of the 5-year OCS oil and gas leasing schedule and any subsequent development of a new 5-year leasing schedule.

Sale-specific resource estimates are developed for use in:

- Exploration and Development (E&D) Reports, EIS's, and other decision documents. The E&D reports contain infrastructure and exploration, development, and production scenarios that appear in sale-specific EIS's. These scenarios, which contain such information as number of wells, types of pipelines, number of platforms, serve as the basis of the analyses in the EIS, which is required by NEPA for any Federal action that could significantly affect the quality of the human environment.
- OCS information reports and updates produced by the OCS Information Program. Resource estimates here will also include those for leased lands.

The procedures used to develop these probabilistic resource estimates are incorporated in a computer model called PRESTO, an acronym for "probabilistic resource estimates—offshore." These estimates are based upon the condition that hydrocarbons are present in the sale area. The PRESTO methodology (see Appendix A) is designed to use the type and amount of data derived from the Geologic and Geophysical Data Acquisition, Evaluation, and Analyses component. Research is constantly being conducted to refine the methodology and procedures involved in PRESTO.

The Resource Estimate Information System (REIS) was designed to enhance the capability of tracking OCS resource estimates over the lease sale process. This is an automated data base which lists resource estimates on a sale-specific basis for: (1) planning area estimates; (2) basin estimates; (3) area identification estimates for input into DEIS; and (4) proposed Notice of Sale estimates made for secretarial decisions.

Economic and Engineering Evaluations for Lease Sales

Once resource estimates are derived, in order to arrive at a net economic value for acreage prior to the sale, economic and engineering criteria, on a sale and tract-specific basis are analyzed, developed, and designed for the purpose of determining bid adequacy and assessing impacts on the objectives of the OCS Lands Act. These criteria include oil and gas prices; inflation and discount rates; exploration, development, production, and transportation costs; supply and demand, and number of platforms, wells, and subsea completions.

1. Economic Parameters—Cost estimates and price assumptions are prepared for each lease sale and include oil and gas prices, transporation costs (pipelines, tankers, etc.), inflation and discount rates, Windfall Profit Tax rates, and exploration, development, and production costs.

2. Bidding Systems Design—Once the amount of hydrocarbons and the associated worth and net costs are estimated, bidding systems must be assigned to the tracts in the sale in order to maximize receipts while insuring adequate competition as required by the OCS Lands Act. Bidding system design involves selecting from a combination of terms and conditions under which a bid is submitted for a particular tract. Currently, the most widely used bidding system is a cash bonus bid with either a 1/6 or 1/8 royalty. The cash bonus is the advance money which is submitted by the bidder for the right to be awarded an oil or gas lease. The royalty rate is a share of the production from the lease either in money or in kind which a lessee is required to pay to the Treasury Department. Market conditions require examination of the various components which comprise a bidding system for each lease sale. The impacts of alternative royalty rates, minimum bid requirements, rental policy, length of lease terms, various bidding systems, are analyzed through the use of a computer model called TSL80 (see Appendix B). In addition, the impacts of existing leases issued under alternative systems are reviewed.

3. Fair Market Value Determinations—Once bids are received and read at the sale, it must be decided whether the high bids for each tract are adequate. With regard to resource evaluation, this includes determinations of viable prospects and tract types, tract-specific resource economic values, when required, and the development and analysis of economic criteria to determine the final acceptance or rejection of high bids.

The bid adequacy system places increased reliance upon competition in the free market through implementation of a two-phase process. Phase 1 is conducted on a tract-by-tract basis and is normally completed within 3 days of the bid opening. It is designed to accept those high bids where the competitive market forces can be relied upon to assure receipt of fair market value or where MMS data indicate the tract does not contain an economically viable prospect.

Those tracts with high bids not accepted in Phase 1 receive further evaluation in Phase 2. The MMS geologists, geophysicists, economists, and petroleum engineers prepare detailed estimates of the economic value of the oil and gas resources on each tract in Phase 2. The high bids are then compared to those estimates of resource economic values.

The resource economic value of tracts offered for lease is determined by calculating the amount of economically recoverable resources, estimating recovery factors, production profiles, exploration and development costs, operating costs, and performing a discounted cash-flow analysis. The MMS uses a computer simulation model to perform this task.

The computer model uses the Monte Carlo or range-of-values technique of handling calculations with uncertain input data. The MMS refers to this as the MONTCAR methodology (see Appendix C). It provides a means to handle a series of subjective judgments about each variable. The burden of expressing the uncertainty is transferred from one or two individuals to the many experts in the various disciplines involved in the evaluation. As with PRESTO, research is constantly being done to refine the methodology and procedures involved with MONTCAR.

Economic and Engineering Studies for the OCS Leasing Program

Advanced computer models and ADP systems and data bases are designed, maintained, updated, and analyzed to serve as the primary support for the conduct of economic and engineering studies that are used throughout the lease sale process. Activities in this support function are described below.

1. Refinement of Computer Models—This refinement includes developing, modifying, and maintaining both the discounted cash flow and resource assessment computer models and methodologies. This also includes redesigning PRESTO and MONTCAR. Refinement also continues on the design, development, maintenance, and update of ADP data bases and systems to support fair market value determinations, and provides an historical data base for economic studies, other analyses, and reports such as the Annual Report to Congress on alternative bidding systems.

2. Economic Studies—Various studies applicable to the entire leasing process are performed. Study issues include the effects of areawide versus tract selection sales, economic value estimates, and the costs and benefits associated with the OCS program, various changes, bid adequacy procedures, and effects of various policies on Government receipts.

Sections 205 and 207 of the OCS Lands Act Amendment each require an annual report to Congress on the scheduling and use of alternative bidding systems in the OCS program and the costs and benefits derived from their use, as well as the use of joint bidding and new market entrants. For these reports, and for recommendations on leasing policy for the overall program as well as individual sales, economic studies are conducted on specific bidding system parameters such as viable royalty rates, minimum bid levels, regulatory changes, lease terms, rental policies, and tract size.

3. Engineering Studies—Consistent and pertinent programwide technological procedures are designed, developed, and implemented, and technology for adverse and severe conditions are assessed. This may include, for example, evaluation of differing development scenarios for exploration and development reports. These products are also oriented to strategic and critical minerals technology and combined economic and engineering feasibility studies.

Chapter 6. Major Products and Responsibilities of the Resource Evaluation Program

In the course of meeting milestones for both the development of the 5-year schedule and specific lease sales, the Resource Evaluation Program generates various reports, studies, estimates, analyses, and procedures. These are listed below on a sale-specific and nonsale-specific basis.

Sale Specific

1. Geology Report—This report is prepared for each proposed lease sale to provide data and information on the general areawide geology of the planning area, resource potential, and environmental geology and geohazards analyses. The information from this report is used in the preparation of the EIS.

2. Area of Hydrocarbon Potential Determination—This is an internal document that is completed prior to the issuance of the Call for Information and Nominations. A brief description of the petroleum potential of the planning area and a map broadly delineating zones as high potential, moderate potential, low potential, no potential, and unknown potential are included in this document.

3. Section 8(g) Letters to Affected States—Section 8(g) of the OCSLA requires that State officials be provided, prior to each proposed sale, information concerning the offering. Specifically, these letters include information on the geographical, geological, and ecological characteristics of the area, an estimate of the oil and gas reserves in the area proposed for leasing, and an identification of any field, geological structure, or trap located within 3 miles of the affected State's seaward boundary.

4. Exploration and Development Reports—E&D reports are developed for inclusion in the sale-specific EIS. The E&D report contains estimates of the quantities of undiscovered economically recoverable resources that could be discovered and produced as a result of the sale. In addition, this report discusses the types and availability of exploration, development, and production technologies that might be employed; estimates of types and number of wells and platforms; methods and facilities likely to be used for transporting hydrocarbons to market; timetables for development and production of leases; and other infrastructure requirements. This information is developed for the sale proposal and each sale alternative.

5. Bidding Systems Options—The Resource Evaluation Program employs the TSL80 Computer Program (Appendix B) before each sale to estimate economic field sizes and the timing and costs of exploration, development, and production. This information is then used to (1) test the impacts of the various bidding systems on future lessees decisions regarding exploration and production, and (2) measure the impacts of the various bidding systems on the total government revenue. In addition, an analysis of the impacts of existing leases issued under alternative systems are reviewed in terms of the latest information available on exploration and development effects. Options are included in decision documents regarding the type and mix of bidding systems to be used. A *Federal Register* notice outlining the reasons for using a particular bidding system is published in conjunction with the Notice of Sale.

6. Cost Estimates and Price Assumptions—Economic forecasts are prepared for each lease sale. They include: current oil and gas prices; the rate of real price increase; inflation and discount rates; Windfall Profit Tax exemptions; and exploration, development, production, operating, and transporation costs.

7. Determination of Bid Adequacy—Detailed analyses of G&G and E&E data and information are used in conjunction with market information received at the lease sale to assure receipt of fair market value for the tracts leased.

8. Resource Estimates Information System—This is an automated data base designed to enhance the capability of tracking OCS resource estimates over the lease sale process.

Nonsale Specific

1. Bonus and Revenue Estimates—Bonus and revenue estimates are developed from the resource estimates and the expected occurrence of those resources. These estimates are developed for revenue projections for budget purposes and other estimates associated with statutory or policy changes. The values are also used to develop economic and social value estimates for lease offering decision documents.

2. Development of New 5-Year Leasing Program—Geology reports and estimates of undiscovered resources for each OCS planning area (including those not on the current schedule) are used in conjunction with other information to develop alternative leasing schedules to be considered in the programmatic EIS for the 5-year program. E&D reports similar to those provided for lease sales are also used as the basis for the EIS analysis. The Resource Evaluation Program provides estimates of net economic value used in the analyses contained in the decision documents.

3. Annual Bidding System Report to Congress—Sections 205 and 207 of the OCSLA each require an annual report to Congress on the scheduling and use of alternative bidding systems in the offshore program and the costs and benefits derived from their use, as well as an analysis of joint bidding, new market entrants, and competition.

4. Biennial Report to Congress on Undiscovered Oil and Gas Resources—Section 606 of the OCSLA requires a biennial assessment of the undiscovered economically recoverable resources of the OCS.

5. Permitting of Prelease G&G Exploration—Before a company can acquire geologic or geophysical data on the continental margin, the company must first obtain an exploration permit from the MMS Regional Director.

6. Acquisition and Security of Proprietary G&G Data and Information—The MMS acquires geologic and geophysical data as a condition for the issuance of an exploration permit under the prelease regulations. The MMS reimburses permittees for a portion of the costs of the data acquired from permittees. Data acquired under permit are considered to be proprietary. Geologic and geophysical data are also acquired from lessees and are generally proprietary. Proprietary data and information are kept in secured areas and stored in vaults in accordance with MMS security standards.

7. Economic Studies—In order to make recommendations on leasing policy for the overall program, economic studies are conducted on specific bidding system parameters such as basic royalty rates, minimum bid levels, and lease terms. These studies consist mainly of generic analyses that are applicable to the program and that are not sale specific.

Glossary

Anticline—An upfold or arch of stratified rock in which the beds or layers bend downward in opposite directions from the crest or axis of the fold.

Area of Hydrocarbon Potential—That part of the planning area which has the primary geologic characteristics favorable for the generation and the accumulations of hydrocarbons.

Bid—An offer for an OCS lease submitted by a potential lessee in the form of a cash bonus dollar amount or other commitments, as specified in the final notice of sale.

Bidding System—A combination of terms and conditions under which a bid is submitted. The economic terms include, but are not necessarily limited to (1) the minimum bid per acre; (2) the yearly rental; (3) the minimum royalty; and (4) the royalty or profit share rates imposed on future production from those tracts leased. See "Royalty."

Bidding Unit—All unleased Federal portions of two or more blocks, whose combined acreage is 5,760 acres or less, which is offered in a specific lease sale as a single leasable entity. See "Tract."

Block—A geographical area of approximately 9 square miles (5,760 acres) which is used in official MMS protraction diagrams or leasing maps. See "Tract."

Bonus—Advance money offered by a bidder for the right to be awarded an oil and gas lease.

Cap Rock—An impermeable rock overlying an oil or gas reservoir that tends to prevent migration of fluids from the reservoir.

Continental Margin—A zone separating the emergent continents from the deep sea bottom.

Continental Shelf—A gently sloping submerged marginal zone of the continents extending from the shore outward through shallow waters to the continental slope.

Continental Slope—A relatively steep, narrow feature paralleling the continental shelf; the region in which the steepest descent to the ocean bottom occurs.

Crude Oil—A mixture of liquid hydrocarbons that exists in natural underground reservoirs as distinguished from refined oils manufactured from it and does not include liquid hydrocarbons produced from tar sand, gilsonite, oil shale, or coal.

Development—Activities following exploration including the installation of facilities and the drilling and completion of wells for production purposes.

Development Tract—A tract located on a common geologic structure with a leased tract, in which the leased tract has proven hydrocarbons.

Dome—A roughly symmetrical upfold, the beds dipping in all directions, more or less equally, from a point; any structural deformation characterized by local uplift approximately circular in outline (for example, the salt domes of Louisiana and Texas).

Drainage Tract—A tract sharing a common reservoir with a leased tract containing hydrocarbons.

Drillship—A self-propelled, self-contained vessel equipped with a derrick amidships for drilling wells in deep water.

Economically Recoverable Resource Estimate—Those resources both identified and undiscovered, that are commercially producible. The sum of reserves, inferred reserves, and undiscovered economically recoverable resources.

Environmental Impact Statement—An analysis required by NEPA in relation to any major action proposed by the Federal Government that could have a significant effect on the human environment.

Exclusive Economic Zone—The maritime region adjacent to the territorial sea, extending 200 nautical miles from the baselines of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

Exploration—The process of searching for minerals preliminary to development. Exploration activities include (1) geophysical surveys, (2) any drilling to locate an oil or gas reservoir, and (3) the drilling of additional wells after a discovery to delineate a reservoir. It enables the lessee to determine whether to proceed with development and production.

Fault—A fracture in the Earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

Field—An area within which hydrocarbons have been concentrated and trapped in economically producible quantities in one or more structural or stratigraphically related reservoirs.

Formation—A bed or deposit sufficiently homogeneous to be distinctive as a unit. Each different formation is given a name, frequently as a result of the study of the formation outcrop at the surface and sometimes based on fossils found in the formation.

Gas Hydrates—Icelike structures of gas and water in which gas molecules are trapped within a framework or cage of water molecules.

Geology Report—A report prepared for each sale providing information on the general geology, resource potential, environmental geology, and geohazards of the planning area.

Guyed Tower—A relatively slender trussed steel column of constant cross-section which supports one or more decks. The tower is held in place by guylines extending radially from the top of the tower to clump weights and anchors on the ocean floor. The tower is designed to move with environmental forces rather than resist them.

Hydrocarbon—Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbons include crude oil and natural gas.

Jack-up—A bargelike, floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water.

Lease—A contract authorizing exploration for and development and production of minerals for a specified period of time over a given area. The meaning of "Lease" depends upon its use in context.

Lease Sale—An MMS proceeding by which leases for certain OCS tracts are offered for sale by competitive sealed bidding and during which bids are received, announced, and recorded.

Lease Term—Duration of a lease. Oil and gas leases are issued for an initial period of 5 years or not to exceed 10 years where such longer period is necessary to encourage exploration and development in areas because of unusually deep water or other unusually adverse conditions. Once production is reached, the term continues as long as there is production in paying quantities.

Lessee—A person or persons to whom a lease is awarded; the recipient of a lease. See "Operator."

Limestone—A rock that is formed chiefly through the accumulation of organic remains such as shells and corals consisting mainly of calcium carbonate.

Minimum Economic Field Size—The amount of resources for a prospect that would give that prospect a positive resource economic value.

Natural Gas—A mixture of hydrocarbon compounds and small quantities of various nonhydrocarbons existing in gaseous phase at the surface or in solution with crude oil in natural underground reservoirs at reservoir conditions.

Net Profit Share—A bidding system for leasing tracts on the OCS that uses the cash bonus as the bid variable and requires a fixed annual rental payment and net profit share payments at a fixed percentage rate that is constant for the duration of the lease.

Official Protraction Diagram—Leasing maps that designate a planning area by using the Universal Transverse Mercator Grid System and is divided into blocks.

Operator—The individual, partnership, firm, or corporation having control or management of operations on a leased area or a portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of rights under an approved operating agreement.

Outer Continental Shelf—The part of the continental shelf seaward of the line that marks State ownership; that part of the offshore lands under Federal jurisdiction.

Permeability—The measure of a rock's ability to transmit fluids; a measure of the ease with which fluids can flow through a porous rock.

Petroleum—An oily, flammable bituminous liquid that occurs in the upper strata of the Earth, either in seepages or in reservoirs; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances.

Porosity—The ratio of the holes, voids, or pores in a rock to its total volume or size. Also, a measure of the capability to contain fluids within void spaces in a rock.

Production—The phase of oil and gas operations that deals with bringing the well fluids to the surface and separating them and with storing, gauging, and otherwise preparing the products for shipment.

Proprietary Information—Geologic and geophysical data, information, and derivatives thereof that cannot be released to the public for a specified term because of Federal law, regulations, or statutes, or because of contractual requirements.

Proven Tract—A previously leased tract, which is now expired, that contains known hydrocarbon reserves. The volume of reserves may or may not be known.

Qualified Bidder—A bidding entity or person who has met the appropriate requirements of 30 CFR 256, Subpart G and of the notice of sale.

Reserves—That portion (in barrels or cubic feet) of an identified oil or gas resource which can be economically extracted using current technology.

Reservoir—A subsurface, porous, permeable rock body in which oil or gas or both have accumulated.

Resources—Concentrations of naturally occurring solid, liquid, or gaseous materials in or on the Earth's crust. These include both identified and undiscovered resources. See "Undiscovered Recoverable Resources."

Royalty—A share of the minerals (oil and gas) produced from a lease; the percentage of oil and gas production, usually fixed at 12 1/2 percent or 16 2/3 percent, either in money or in kind which a lessee is required to pay the Treasury Department.

Sandstone—A sedimentary rock made up of sand-size grains that usually consist of quartz more or less firmly united by some cement (as silica, iron oxide, or calcium carbonate).

Seismic—Pertaining to, characteristic of, or produced by earthquakes or Earth vibration; having to do with elastic waves in the Earth.

Seismic Survey—A method of geophysical prospecting using the generation, reflection, refraction, detection, and analysis of elastic waves in the Earth.

Semisubmersible—A floating offshore drilling structure that has hulls submerged in the water but not resting on the seafloor.

Shale—An indurated rock that is formed by the consolidation of clay or mud.

Sliding Scale Royalty—A bidding system for leasing tracts on the OCS that uses cash bonus as the bid variable and where the royalty payment is not fixed but is dependent upon the value of production during each calendar quarter.

Source Bed—Rocks containing relatively large amounts of organic matter that is transformed into hydrocarbons.

Spud—To begin drilling a well.

Statute Mile—A common measure of distance equal to 5,280 feet, or 1,609 meters.

Stratum (pl. Strata)—A tabular mass or thin sheet of rock made up usually of a series of layers lying between beds of other kinds.

Tract—A designation assigned, for administrative and statutory purposes, to a block or combination of blocks that are identified by an official protraction diagram prepared by the MMS. A lease is granted for a tract. A tract may not exceed 5,760 acres unless it is determined that a larger area is necessary to comprise a reasonable economic production unit. See "Block" and "Bidding Unit."

Trap—A geologic feature that permits the accumulation and prevents the escape of accumulated fluids (hydrocarbons) from the reservoir.

Undiscovered Economically Recoverable Resources—Resources outside of known fields estimated to exist in potential commercial accumulations. The presence of these resources is postulated on the basis of geologic, engineering, and economic inferences.

Undiscovered In-Place Resources—Quantities of oil and gas estimated to exist outside known fields, without reference to economic or technological factors.

Viable Prospect—A prospect having a "most probable" conditional resource level that exceeds the minimum economic field size for that particular cost regime.

Wildcat Tract—A tract which is not a drainage, development, or proven tract, and has a high risk in addition to sparse well control.

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Appendix A. PRESTO

PRESTO (**P**robabilistic **R**esource **E**stimates, **O**ff-shore) is a computer program used by the Minerals Management Service to develop estimates of offshore oil and gas resources for eventual use in a number of public documents. The program uses the types of geologic and geophysical (G&G) data normally used by the oil industry to locate and define potentially hydrocarbon bearing geologic features. PRESTO has the flexibility to evaluate resources in frontier as well as mature areas and accomodates a wide range of uncertainty in terms of input parameters.

Preliminary inputs to PRESTO are developed from raw geologic, geophysical, petrophysical and geochemical data by regional office geologists and geophysicists. Potential traps are located horizontally and vertically within the geologic section and mapped in terms of closure and total area using geophysical data. Initial judgments on the probability that the trap exists as mapped are subjectively made on the basis of data quantity, quality, and the probable accuracy of the depth-conversion function. Geophysical data also are used to determine if the feature is capable of trapping hydrocarbons.

Geologic data (well cuttings, cores, stratigraphic extrapolations, etc.) are used in assessing the probability that the trap contains rocks having suitable reservoir characteristics. A probability that hydrocarbons were actually generated is developed from an analysis of source rock type and distribution with respect to regional thermogenesis.

The probability that a well drilled to test the prospective trap described above will contain hydrocarbons is thus the product of three major factors, i.e., reservoir probability x structural probability x source probability = the probability that the trap contains hydrocarbons. This probability value is refined by various second-order geological modifiers which relate to hydrocarbon occurrence such as existence of migration pathways, vertical position of the trap with respect to thermally mature source rocks, whether or not the trap is part of a productive trend, presence of faulting within the trap, presence of sealing lithologies and other structural confidence factors. These modifiers are given numerical values and cumulatively define the final probability for a given trap.

In frontier areas, extensive use is made of basin analogs in developing preliminary geologic and geophysical input to PRESTO and in determining realistic probability/risk values. An analysis of analogous producing basins and available G&G data are used to develop a geologic model of a given basin describing expected lithologies, environments of deposition, age relationships, reservoir parameters (porosity, permeability, water saturation, yield, pay thickness) which are each given minimum, maximum, and most likely values, and general structural style. A probability that hydrocarbons exist in at least one of the prospects as modelled is estimated. The basin model is then divided into subareas (or plays) which are based on equivalent sets of parameters, i.e., each parameter set numerically defines all potential traps within a given subarea.

The reservoir parameters are converted to zone level inputs for PRESTO. (A zone is the smallest geological element used in the program and resources are first calculated at that level. Zone resource estimates are aggregated through prospect, subarea and basin levels to arrive at the total resource estimate for each basin. Basin estimates are then aggregated to yield planning area totals.) Seven variables are used in each zone resource estimate calculation. (Fig. 20) They are: (1) acreage, (2) pay thickness, (3) proportion of zone gas bearing, (4) gas/oil ratio (in ft^3 of associated gas/barrel), (5) oil recovery factor (in bbl/acre-foot), (6) gas recovery factor (in Mcf of nonassociated gas/acre-foot), and (7) condensate yield (in bbl/MMCf of nonassociated gas). These parameters can be entered as single values or as probability distributions depending on the degree of certainty to which they are known. The final zone level inputs to PRESTO are estimates of the probability that any discovered hydrocarbons will be either all oil or all gas, or a mixture of the two. These values are given as simple percentages.

In addition to zone level reservoir parameters, a number of other inputs are required, all of them single-point values. Four levels of risk (zone, prospect, basin, and area) are subjectively estimated. Zone risk is a representation of the probability that the zone in the prospect being evaluated will be dry. If a prospect contains only one zone or if a number of zones have been summed to generate a single prospect, then the zone and prospect risks are numerically identical. Prospect risk is a measure of the probability that the prospect as modelled would be dry. Prospect risk also forces an arithmetic dependency among individual zones within a prospect. Since zone risk must be equal to or greater than prospect risk, if prospect risk values are high (near 1.0) then zone risks are constrained to a narrow range between the prospect risk and 1.0. The degree of dependency is thus high and implies that a discovery in one zone greatly increases the chances for success in other zones. The converse is also true. A low risk implies that individual zone risks may be unrelated and that a discovery in one zone has little effect on the chances in other zones. This "dependency" is common to all levels of geologic risk.

Basin risk is an assessment of the probability that all prospects within a basin would be dry. The last level of risk in the succession is area risk or the probability that all basins in the area will be dry.

A minimum economic field size is entered into PRESTO so that economic considerations can be factored into the resource estimation process. Minimum economic field sizes are usually derived by another program (MONTCAR) which factors in prospect size, distance from shore, water depth, drilling depth, production decline curves, dollar value of production and other drilling, production and infrastructure costs. One output of MONTCAR is a discounted cash flow analysis of the amount of resources needed to cancel production and development costs, i.e., the minimum reserves needed to generate a positive net value.

In frontier areas such as Alaska and the Atlantic, minimum reserves for basins and subareas are input because no production, transportation, and distribution infrastructure presently exists in these areas. The absence of in-place infrastructure greatly affects production and development costs. Basin and subarea minimum economic resources factor in the need for large investments in start-up costs which are not required in mature producing areas such as the Gulf of Mexico or parts of the California offshore.

Infrastructure data are optional entries. (Fig. 20) Prospect infrastructure includes the number of exploration and delineation wells, ratios of development wells per volume of oil and gas, and the number of platforms. Minimum economic field sizes at the prospect, basin, and area levels are also entered. (A gas to oil conversion factor is used to convert gas to barrels of oil equivalents (BOE). The BOE conversion can be given as an energy or economic equivalency.)

The program includes a provision which accounts for dependencies between variables through the use of a correlation matrix. (Fig. 20) If, for example, acreage and pay thickness are thought to be related in a given area, this relation can be assigned a value (correlation coefficient) dependent on the sign and strength of the correlation. The correlation coefficient then constrains the inherent randomness of the Monte Carlo process by limiting the pairing of variables, i.e., if area and pay thickness have a strong negative correlation (area increases and pay thickness decreases) most pairings of thick pay with large area will be eliminated from the volumetric calculation. This subroutine also includes an internal positive/definite check to ensure that all implicit correlations have been accounted for.

PRESTO calculates conditional and risked oil and gas resource estimates. Conditional estimates assume that economically recoverable accumulations of hydrocarbons are present in the area under study. If hydrocarbons exist in an area, you would expect to find the conditional amount. Because of uncertainties in both the quantity and location of possible resources, the conditional estimates are given as probability distributions rather than as single values. Risked estimates are calculated by deriving a value for the probability of hydrocarbon occurrence (probability is the complement of risk) and multiplying it by the conditional estimate. Each point on the conditional distribution multiplied by the probability will yield a corresponding point on the risked curve. The mean of a conditional distribution multiplied by the probability of hydrocarbons existing will give the mean of the risked distribution. (This property is unique to the means, and does not apply to the other percentiles.)

PRESTO calculates conditional zone-specific volumetric resource estimates by the application of the following arithmetic formulae:

- Volume of oil (bbl) = (acreage x pay thickness x 1-proportion of zone gas bearing x oil recovery factor)

- Volume of nonassociated and associated gas (MMCF) = (acreage x pay thickness x proportion of zone gas bearing x gas recovery factor) or ÷ 1000

- Volume of solution gas (MCF) = (gas oil ratio x oil volume) or ÷ 1000

- Volume of condensate (bbl) = (condensate yield x nonassociated and associated and associated gas)

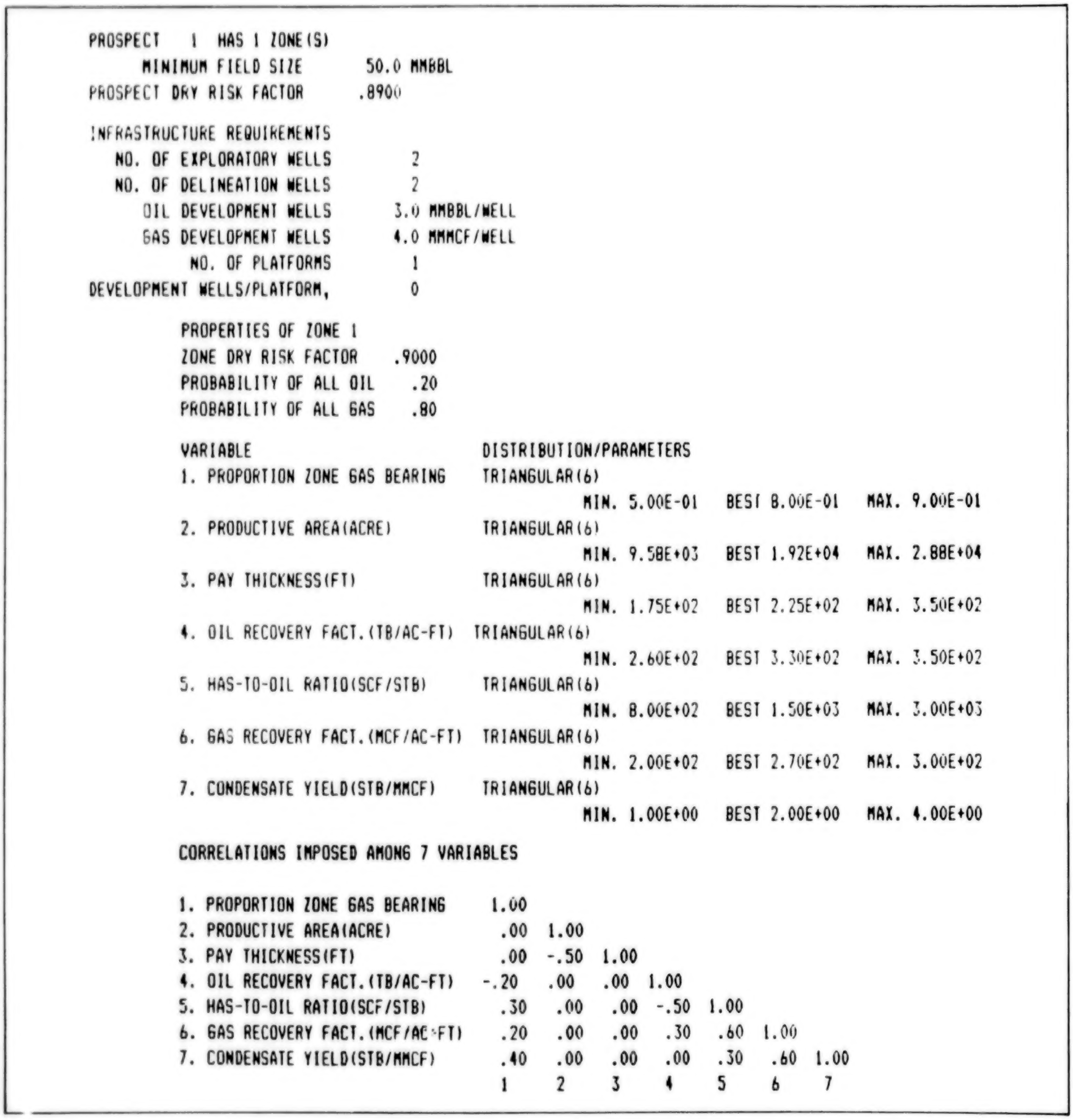
The program then determines if the reservoir contains only oil, only gas, or both. If the reservoir contains both, a user supplied distribution determines the ratio. The program then uses Monte Carlo simulation techniques, or Latin Hypercube sampling to "drill" prospects utilizing the previously discussed user supplied physical representation of each prospect. A random number seed is first derived from the time of day and a sequence of random numbers is calculated from it by a program subroutine. A conditional dry prospect risk is then calculated using the relation:

$$\text{Conditional dry prospect risk} = \frac{\text{prospect risk-area risk}}{\text{1-area risk}}$$

For each trial a random number is compared to the conditional dry prospect risk to determine whether the prospect is productive or dry. (If the random number is greater than the conditional dry risk, then the trial is productive.) If a trial is productive, the input reservoir parameters are sampled and a resource volume is calculated. Each prospect is tested on a specified number (up to 10,000) of trials and the results of each trial are aggregated and stored.

As the conditional prospect resource estimates are generated, they are compared to a user provided minimum economic field size. If the estimate exceeds the minimum economic field size the estimate is stored, if it is less, the trial is not economic and a value of zero is entered. The process proceeds until the specified number of trials is completed. All trials then aggregated and the results are given as a probability distribution for the basin. A mean, 5th percentile and 95th percentile conditional resource estimate is derived from the probability distribution curve and are the values normally used in reporting resource estimates.

The **PRESTO** model is periodically updated to include new capabilities or new methods of displaying or classifying resource estimate data. A new method for dealing with unidentified prospect resources is currently under development. An effort to improve the program through the use of interactive prompts and graphics is progressing.



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PROSPECT    1  HAS 1 ZONE(S)
      MINIMUM FIELD SIZE        50.0 MMBBL
PROSPECT DRY RISK FACTOR       .8900

INFRASTRUCTURE REQUIREMENTS
   NO. OF EXPLORATORY WELLS           2
   NO. OF DELINEATION WELLS           2
      OIL DEVELOPMENT WELLS        3.0 MMBBL/WELL
      GAS DEVELOPMENT WELLS        4.0 MMMCF/WELL
           NO. OF PLATFORMS           1
DEVELOPMENT WELLS/PLATFORM,           0

          PROPERTIES OF ZONE 1
          ZONE DRY RISK FACTOR    .9000
          PROBABILITY OF ALL OIL    .20
          PROBABILITY OF ALL GAS    .80

          VARIABLE                        DISTRIBUTION/PARAMETERS
          1. PROPORTION ZONE GAS BEARING   TRIANGULAR(6)
                                                      MIN. 5.00E-01   BEST 8.00E-01   MAX. 9.00E-01
          2. PRODUCTIVE AREA(ACRE)         TRIANGULAR(6)
                                                      MIN. 9.58E+03   BEST 1.92E+04   MAX. 2.88E+04
          3. PAY THICKNESS(FT)             TRIANGULAR(6)
                                                      MIN. 1.75E+02   BEST 2.25E+02   MAX. 3.50E+02
          4. OIL RECOVERY FACT.(TB/AC-FT)  TRIANGULAR(6)
                                                      MIN. 2.60E+02   BEST 3.30E+02   MAX. 3.50E+02
          5. HAS-TO-OIL RATIO(SCF/STB)     TRIANGULAR(6)
                                                      MIN. 8.00E+02   BEST 1.50E+03   MAX. 3.00E+03
          6. GAS RECOVERY FACT.(MCF/AC-FT) TRIANGULAR(6)
                                                      MIN. 2.00E+02   BEST 2.70E+02   MAX. 3.00E+02
          7. CONDENSATE YIELD(STB/MMCF)    TRIANGULAR(6)
                                                      MIN. 1.00E+00   BEST 2.00E+00   MAX. 4.00E+00

          CORRELATIONS IMPOSED AMONG 7 VARIABLES

          1. PROPORTION ZONE GAS BEARING    1.00
          2. PRODUCTIVE AREA(ACRE)           .00  1.00
          3. PAY THICKNESS(FT)               .00  -.50  1.00
          4. OIL RECOVERY FACT.(TB/AC-FT)  -.20    .00   .00  1.00
          5. HAS-TO-OIL RATIO(SCF/STB)       .30   .00   .00  -.50  1.00
          6. GAS RECOVERY FACT.(MCF/AC-FT)   .20   .00   .00   .30   .60  1.00
          7. CONDENSATE YIELD(STB/MMCF)      .40   .00   .00   .00   .30   .60  1.00
                                               1     2     3     4     5     6     7
```

FIGURE 20. Screen print of user Input for PRESTO

Appendix B. Overview of TSL80

The two-stage leasing computer program (TSL80) is designed to simulate alternative one- and two-stage mineral leasing systems. TSL80 models a generalized process for acquiring rights to the exploration, development, and production of mineral resources on public lands. The program can be used to examine a variety of leasing systems based on cash-bonus, royalty, or profit-share bidding, and a number of prespecified bidding parameters, such as fixed- or sliding-scale royalties or four variations of profit sharing when used with cash-bonus bids.

TSL80 can be used as a flexible policy-planning and evaluation aid. It permits the user to test various strategies under any number of scenarios. Each strategy to be tested is a combination of variables that can be controlled by the user or the entity he represents. For example, the lessor, such as the Federal Government, can determine the leasing system as well as its specific conditions (e.g., fixed-royalty rates or profit-share rates under a cash-bonus bidding system). Each scenario, on the other hand, is a combination of variables that are beyond the control of the user. Using the same example as above, the Federal Government cannot control the magnitude of the winning bonus bid. Other typical scenario variables are prices, costs, and the amount of resources that can eventually be produced from the tract.

TSL80 is more than a simple accounting model in that it dynamically simulates many of the critical decisions made by the lessee and the outcomes of these decisions. For example, following the discovery of oil during exploration, the model evaluates whether the lessee should proceed with confirmation and delineation drilling or abandon the lease and take a tax write-off.

The model uses the Monte-Carlo approach in testing strategies against scenarios. The principal advantage of the Monte-Carlo approach is that it allows the user to obtain a summary of the combined effects of a large number of uncertain scenario variables in a single run of TSL80. This is useful when one recognizes that there are billions of combinations of prices, production costs, production profiles, and sizes of discoveries on a tract that *could* occur, of which only one actually *will* occur. Therefore, because it is impossible to predict which particular combination will occur, TSL80 provides the user with *expected* results—such as the average discounted cash flow the lessee can expect from the tract.

What makes TSL80 extremely powerful relative to a typical discounted cash flow calculator is that it is designed to optimize a variety of operating decisions. For example, it always chooses and uses the best combination of production capacity and profile for any particular discovery size. It also determines the most profitable point at which the lessee should terminate production and abandon the tract, and for consistency recalculates the depletion deductions for tax purposes. Finally, perhaps the most useful feature of TSL80 is its ability to generate a bid reflecting the bidding strategy of the lessee and then provide summary statistics based on that strategy.

Appendix C. MONTCAR Methodology

Determination of the resource economic value of a tract offered for lease involves calculating the amount of economically recoverable resources, estimating recovery factors, production profiles, exploration and development costs, operating costs, and performing a discounted cash-flow analysis. The Minerals Management Service uses a computer simulation model to determine the resource economic value of certain OCS tracts offered for lease by the Federal Government.

The computer model utilizes the Monte Carlo or range-of-values technique of handling calculations with uncertain input data. It provides a means to handle a series of subjective judgments about each individual variable. The burden of expressing the uncertainty is transferred from one or two individuals to the many experts in the various disciplines involved in the evaluation. This method explicitly recognizes the probabilistic nature of all variables affecting the evaluation and calculates a large number of possible outcomes based upon random samples from input probability distributions.

Much of the geologic and engineering data (e.g., areal extent and thickness of the hydrocarbon pay zone, porosity, initial water saturation, recovery factors, production rates, product prices, costs, etc.) used to evaluate a tract is known with varying degrees of uncertainty. Providing a single number for the resource economic value of a tract is somewhat misleading since it provides no insight as to the relative uncertainty involved. The Monte Carlo technique provides a range of resource economic values (net present worth (NPW)) for the tract with the probability of each value occurring being a direct consequence of the data uncertainty.

The logic of the Monte Carlo simulation method can be described as a five-step process.

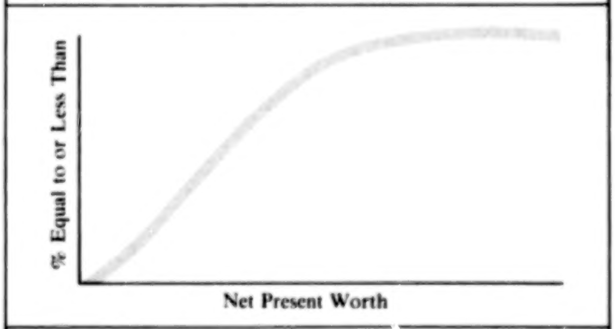
Step 1. Estimate the range and distribution of possible values of each variable that will affect the ultimate outcome of the venture. This requires judgments from geophysicists, geologists, paleontologists, stratigraphers, economists, and engineers. The most critical step in the process is quantifying the uncertainty involved through the use of these probability distributions. The amount of data concerning the prospect in question, the amount of information about the trend within which a prospect is located, and the experience of the scientists making the evaluation will dictate the type and shape of the probability distribution curves for each variable.

Step 2. Select, at random, one value from the distribution of each variable. Compute the tract value using this combination of selected values. This determines one point in the final distribution of possible tract values. Select, at random, a second value from the distribution of each of the variables. Again compute the resulting tract value. This is the second point in the distribution of possible tract values. The random selection is statistically done in such a way that, if a large number of random selections are made (1,000 or more), the distribution of the randomly selected values closely resembles the distribution that was read in.

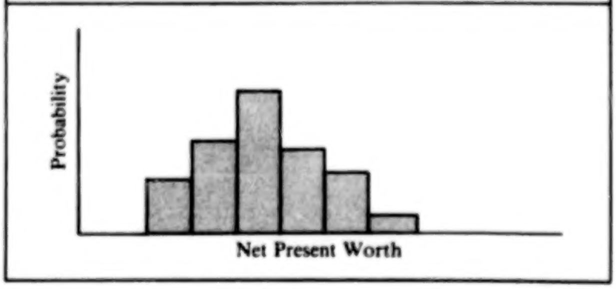
Step 3. Repeat the process 1,000 or more times, each time with a set of values selected at random from the distribution of each variable. Enough combinations of variables should be considered to adequately describe the shape and range of the distribution of tract values.

Step 4. The final output is a number of possible NPW values for the tract whether it is productive or dry. The program generates a cumulative probability distribution plot and a probability histogram for the productive NPW values, for example:

Cumulative Probability Distribution



Probability Histogram



The method in effect constitutes a shift of emphasis regarding subjective judgments. Instead of requiring a single judgment about how a series of variables will interact collectively, a series of judgments are made on how each individual variable will occur.

Step 5. The means of the productive and dry NPW distributions are determined, the probability of hydrocarbons being present, and factors for bonus write-off and depletion are applied to determine the expected (risked) NPW of the tract. This is the mean of the range of values (MROV) commonly referred to as the Government's reservation price.

The program also calculates what the expected NPW would be today if a tract was not leased until a later date, taking into account differences in income and excise tax payments and royalty or profit share payments; this is called the delayed MROV (DMROV).

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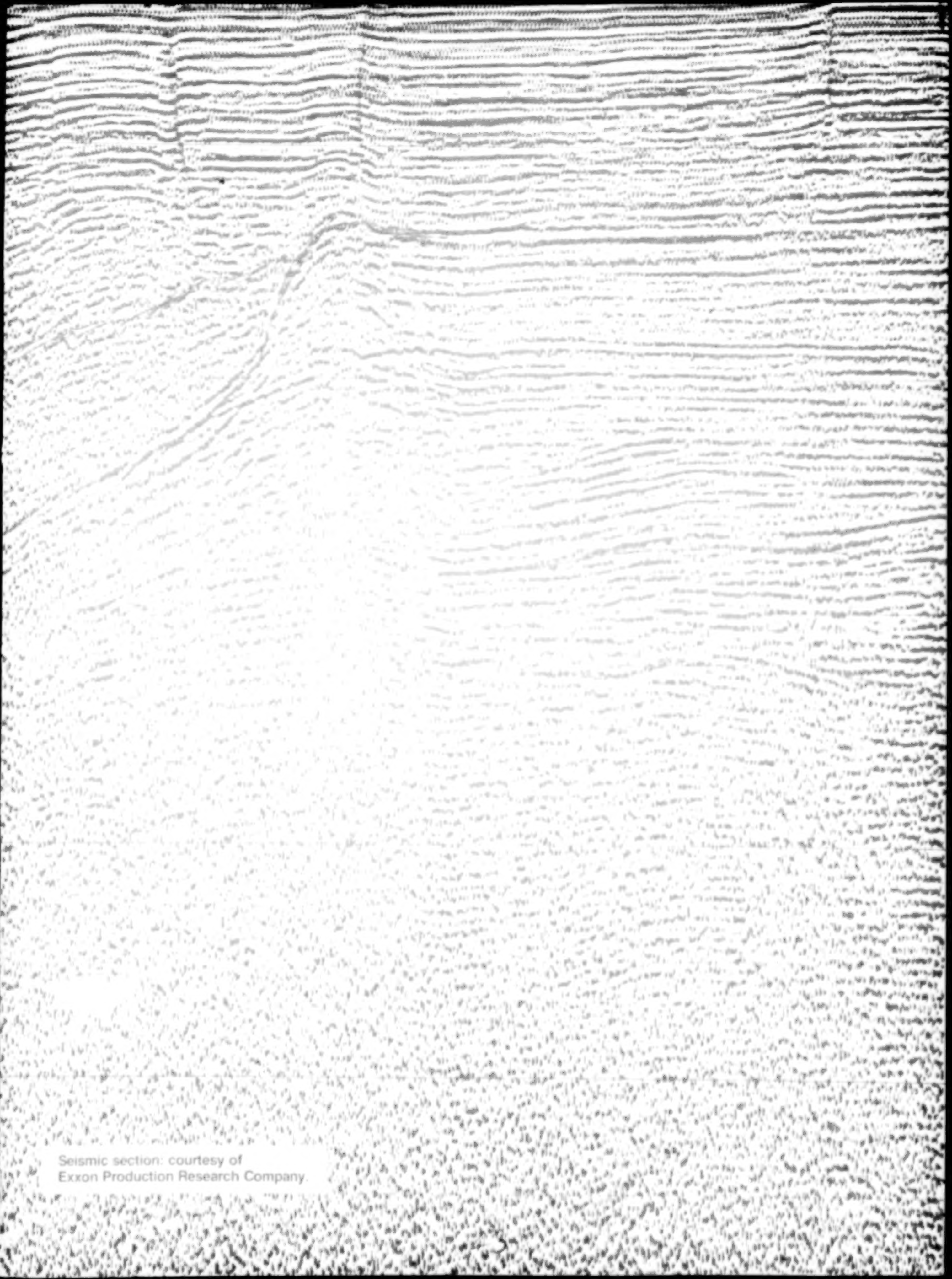

Seismic section: courtesy of
Exxon Production Research Company.

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